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ANALYSIS OF AUTOMATION vs LEADTIME

VOLUME II

PLANT EQUIPMENT PACKAGE MODERNIZATION PROGRAM

KAISER ENGINEERS

In Association with Stetter Associates, Inc.

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An analysis of different levels of automation and/or mechanization of production lines in two P&E, two LAP, and one metal-parts Army Ammunition Plant. Provides guidelines to assist the Government in determining the appropriate combination of automated/mechanized versus manually-operated production lines to be implemented.

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I. INTRODUCTION

A. BACKGROUND

As part of the Plant Equipment Package (PEP) Modernization Program studies under Contract DAA21-75-C-0303, the U.S. Army directed Kaiser Engineers (KE) in association with Stetter Associates (SAI) to undertake a study of selected munitions production lines utilizing automation and mechanization techniques; to identify and evaluate automation applications; and, assess their potential impact on startup time, after layaway.

Several Government-owned contractor-operated (GOCO) Army Ammunition Plants (AAP's) in the United States are currently planning and implementing modernization programs to improve production capabilities. The modernization programs include the application of the latest developments in process technology and control systems.

Historically, the manufacturing usage of the terms automation and mechanization represented clearly defined levels of technology and implementation, with mechanization referring primarily to standardized mechanical handling systems designed to augment the effectiveness of workers, whereas automation tended to refer to feedback systems employing higher levels of technical sophistication and potential programming capability. In current usage, the distinction has been largely blurred and in today's manufacturing plants, higher levels of mechanization include some feedback capability. Therefore, it is feasible to describe both mechanization and automation with the same general parameters.

Government munitions production requirements vary and the production equipment in use becomes inactive or in layaway status for indeterminate periods of time. The capability of a munitions plant to reactivate highly mechanized and/or automated production lines from layaway to a specified mobilization production rate has become suspect.

B. OBJECTIVES

The objectives of the study are as follows:

- Identify the munitions production automation and mechanization applications, establish complexity levels and assess their impact on startup times.

- Provide guidelines to assist the Government in determining the appropriate combination of automated/mechanized versus manually operated production lines to be implemented for the selected or similar production lines.

C. SCOPE

The following five representative AAP's was specified for study:

AAP	Manufacturing Classification
LONE STAR	Load Assembly and Pack (LAP) and fuze lines
IOWA	LAP
RADFORD	Propellants and Explosives (P&E)
VOLUNTEER	Explosives (E)
SCRANTON	Metal Parts

The plants selected are participating in the modernization program. Their ammunition item/component production lines, based on the requirements of their Technical Data Packages (TDP) represent cross sections of production processes and operations that are currently used or planned for use within the munitions production base.

In addition, information gathered during the current PEP modernization program was evaluated for its contribution to this study, with interactions by study team and PEP personnel.

D. TECHNICAL APPROACH

The data gathered from visits to the candidate AAP's formed the major information bases for the study.

At least one specific production line in each of the five AAP's was selected for analysis as being representative of a great degree of automation and/or mechanization.

Information derived from other assigned tasks under the PEP modernization program, such as layaway, was evaluated for its contribution to this study. Data were solicited and collected on state-of-the-art techniques and equipment for automation and mechanization as applied to munitions production and processes, and available data on the

historical plant startup requirements, actual startup times, and problems encountered were collected. The data were compiled and evaluated to provide an analysis of the following:

- Relationships between automation, mechanization, operating modes, startup times, and problem areas.
- Compatibility of existing automation with the production equipment.
- Major problem areas that may arise during layaway and startup.
- Skills requirements for tooling, startup, operation, maintenance, and support of automated systems.
- Recommendations/guidelines.

E. ORGANIZATION OF REPORT

In addition to the Introduction and Summary, this report includes plant data and its evaluation, a discussion of pertinent startup considerations, conclusions, recommendations and guidelines and an appendix of relevant backup information.

II. SUMMARY

A. GENERAL

As part of the PEP Modernization Program the Army directed the Kaiser Engineers/Stetter Associates, Inc. (KE/SAI) team to study munitions manufacturing lines in five (5) selected Army Ammunition Plants. The plants selected were Lone Star, for their load, assembly and pack (LAP) operations; Iowa also for their LAP operations; Radford, for their propellants and explosive manufacture; Volunteer, for their explosive manufacture; and Scranton, for their metal parts manufacture. These plants are currently implementing modernization programs and their munitions production processes and operations are representative of the planned production base.

The purpose of the study was to gather the necessary data to enable the Army to:

1. Identify the munitions production automation and mechanical application, established complexity levels and assess their impact on startup time.

2. Provide guidelines to assist the government in determining the appropriate combination of automated/mechanized versus manually operated production lines to be implemented for the selected or similar production lines.

The collected data and subsequent evaluations are documented in this study report.

B. CONCLUSION

Automation/mechanization applications will cause an impact on startup time. The degree of impact, in itself, cannot be isolated unless other probable contributors such as layaway condition, followon maintenance, startup procedures, spare parts availability, skill retention and funding are assumed to have zero effect on startup time. However, the plant surveys revealed that this is not a valid assumption. The survey results are tabulated below:

Variable	Required for Minimum Startup Time	Actual Condition of Five Plants Surveyed
Layaway and followon maintenance	Instructions and procedures properly implemented	Medicore to nonexistent
Startup procedures	Engineered procedures prior to layaway	Nonexistent
Spare parts	Available at time of startup	No provision
Skill retention	Experienced personnel	No provision; headquarter studying problem
	(oe) Total Documentation	One Plant (Volunteer) has attained 50% of such a program. Other four plants - nothing
Funding	Adequate to support above	Insufficient to nonexistent

C. PRODUCTION LINE ASSESSMENT

1. M557 Fuze Line (Lone Star AAP) The line for the M557 fuze was selected for study on the basis of its inactive status and degree of mechanized control complexity. The M557 fuze line has a straight line "floating pallet" configuration and a combination manual and automatic assembly function. The equipment had been in operation for about three years before layaway in 1975. Startup problems may be anticipated because of extensive number of operations, and mechanical and control complexity. Moreover, lack of suitable documentation for layaway and equipment preservation methods will have a decided effect on startup time.

2. Warhead Load Line (Iowa AAP) The warhead loading system is a batch operation with a control system that includes manual and computer monitoring. The conditioning cycle is monitored and controlled by a computer; deviation from the established conditioning

cycle is recorded on a teletype and signals that corrective action is required. The startup time is not impaired since a manual mode can be initially employed. Surveillance monitoring will be transferred to the computer control mode when the line is operable.

3. Detonator Loader Line (Iowa AAP) The detonator loader line is a conventional mechanical design common to industry. The dial-type indexing rotary table machine with automatic cycle is a mechanized multiple station unit fitted with locating and holding fixtures. It is an excellent example of a machine with a high degree of mechanization with a relatively simple control system. If properly laid away and maintained, the machine should not present any problems at startup time.

4. Single Base Propellant Line (Radford AAP) The continuous, automated, single base propellant line (CASBL) was selected as representative of a highly complex remotely controlled and monitored automated processing facility. Four large buildings are required for the process and include modernized, automatic processing and handling equipment. The operational mode is direct digital control (DDS). Two identical computers are used. One computer functions as the control processor, the other, in a backup mode, functions as a supervisory processor performing off-line functions. The system has over 300 analog input sensors and nearly 100 DDC loops. The computer software is still in the process of development and debugging. Although industrial-type analog process controllers exist in performing manual set-point control, funding constraints permitted their inclusion as on-line backup to the DDC system for only a limited number of process control loops. The line is not expected to be operational until 1978-1979.

5. TNT Lines (Volunteer AAP) There are six TNT continuous nitration lines which were evaluated in depth. Direct digital control mode is used on lines 1, 4, 5 and 6. The remaining two are manually operated. The computer equipment is similar to that discussed in the paragraph on the Continuous Single Base Propellant line at Radford AAP. The Volunteer computer control is supported by analog and manual backup controls which should reduce potential problems at startup.

6. Projectile Metal Parts Line (Scranton AAP) Projectile metal parts are manufactured beginning with the raw material in billet form to the finished painted projectile bodies, complete with rotating bands

and lifting eyes, strapped on shipping pallets. It is an industrial-type process utilizing conventional equipment. Standard layaway practices should be adequate.

D. RECOMMENDATIONS/GUIDELINES

1. Communication. Communication between plants with similar technologies should be encouraged. It is recognized that plants with similar technologies discuss process technology; however, discussions should include standardization of equipment for similar product lines, common layaway and startup problems, etc.

2. Layaway Instructions. Instructions pertaining to service and supply lines for layaway are insufficient; plans for systematically preparing idle lines for layaway do not exist; scheduled maintenance of idle equipment is lacking; and documentation for lines to be laid away or in layaway are needed.

   Update TM 38-260. Set up special group of qualified industrial personnel to develop the most suitable procedures.

   The current layaway manual does not have provisions for layaway of advanced technical items; especially computer and related electronic equipment. It is recommended that this document be revised periodically to keep it up-to-date. Supplementary procedures tailored to suit conditions not covered in the layaway manual should be included where applicable.

3. Past Records. History of previous startup has not been documented. Records should be compiled for future reference to minimize startup problems.

4. Followon Maintenance and Startup. Supplement standard startup procedures with instructions to suit individual line or machine special characteristics. We recommend that instructions be developed and attached to standard startup procedures for equipment on a plant-by-plant basis.

5. Production Flexibility. Many existing lines will produce efficiently only at full mobilization. Moreover, this production philosophy is reflected in current modernization programs. Production lines should be designed with the capability to manufacture the product economically at less than full mobilization rate.

6. Standardization. Plants producing the same products should attempt to standardize on processes and equipment in an effort to optimize the production methods. Free exchange of ideas and information between the various plants should be practiced.

7. Startup Exercise. Conduct an actual startup exercise that would be synomynous to a "fire drill". Although each of the plant operators have signed statements to the effect that startup of their lines currently in a layaway condition can be reactivated within the specified mobilization time period, they privately admit that it would be difficult or impossible to satisfy the condition. This can be traceable to the lack of direction concerning layaway, absence or incomplete compiling of layaway and startup instruction documentation, lack of spare parts, lack of necessary skills, and lack of adequate funding.

   A complex mechanized and automated production line should be selected, at random, for startup. A contractor (outside or inside) with experienced personnel such as production engineers, machinists, millwrights etc. who are familiar with production line operations should conduct the program. In addition to using any documented information available with the layaway, the contractor should take whatever steps necessary to bring the line to full mobilization. After a short period of operating to production specification, the line should be shut down and put in layaway. Layaway documentation should include any modifications of details resulting from this exercise.

   This should provide the government with an important assessment of startup problems, from which guidelines for future action can be established.

8. Design. It should be recognized and emphasized, that munitions plants have two unique characteristics. These are:

   1. Repetitive Operations - Unlike industry, the end product specifications do not change from year-to-year. Change generally occurs only when new total weapons systems are developed.

   2. Inactivation - The indeterminate production requirements and the shut down and layaway of equipment for indeterminate periods of time, are unique to the munitions industry. This points up that the basic criteria used for plant design in private industry are not applicable for munitions plant operations. Equipment and

plants should be designed: first, with the capability to satisfy low production levels as well as future mobilization requirements and second, to facilitate layaway and startup. Moreover, any design development should reflect recognition of inactive periods and concentrate on the selection of equipment with the least complex types of controls that can satisfy productivity, safety, economics, etc., and permit efficient layaway, followon maintenance and startup. The emphasis has to be on simplicity of operation and still maintain productivity within the constraints of safety, human and environment, ecology and social considerations. Material and energy resources are critical and require improved control techniques to upgrade process and product quality. Effective implementation of the operation may require, in varying degrees, the application of automation/mechanization. Line reactivation can be accomplished within a shorter time by progressively changing from manual to automatic control.

The current method of cost justification for modernization is predicated on full production for a determinate period of time. The true economic key is operational and maintenance costs. Equipment amortization schedules cannot be formulated based on indeterminate periods of production and layaway. In addition, planners misinterpret modernization which can apply to refurbishment and replacement as well as new production on a continuous basis. Munitions plants have to be geared to full production, intermittent production and shut down for extended periods. The design approach to the application of advanced technology requires a different approach. The emphasis has to be on the simplicity of operation, better materials suitable to withstand the detrimental effects of environment while in layaway and, capability to achieving specified minimum and maximum production rates when activated.

9. Skills Retention. Skills retention is a primary factor in providing an efficient startup for an inactive production line. Methods for retaining operational proficiencies for munitions manufacture fall into three categories. First, continuing on site employment of a full roster of personnel who are experienced in the operations can provide rapid startup capabilities. As time and attrition lessen the number of experienced people, those remaining can serve as instructors to new employees for on-the-job training. Second, a contemporary training development is effective and includes special format manuals, slides, animated cartoons, movies, cassettes for

TV presentation, simulated exercises, etc. Third, advanced technology now permits the practical application of plug-in solid state modules programmed to direct a sequential series of operations. When directives are issued for layaway these "black boxes" can be unplugged and easily stored. Activation of the module may occur through manual means, another module, microprocessor, etc.

10. Funding. Inadequate funding is the most significant factor contributing to startup delay, because of the effect that it has on preparation for layaway and followon maintenance.

III. PLANT EVALUATIONS

A. PLANT SURVEY METHODOLOGY

The five AAP's selected for inclusion in this study are participating in the plant and process modernization program and contain ammunition item/component production lines that represent cross-sections of production processes covering metal parts fabrication; load, assemble and pack operations; and the manufacture of propellants and explosives. At each plant visited, machines and production lines included in this study were evaluated to determine:

1. The degree of automation/mechanization utilized

2. The amount and effects of automated inspection

3. The complexity and size of the basic machine structure(s) or process equipment

4. The type and degree of controls for production lines.

Where possible, the mechanized equipment was compared with a simple manual, mechanically aided operation. Where equipment was idle, an assessment was made as to condition of layaway based on the time elapsed since shutdown.

At each plant the production line supervisors and operators were consulted regarding manufacturing operations and the role of the equipment; and, after completing the review of each line, line operations and equipment were discussed with plant management and engineering personnel.

A specific production line was then selected for more intensive study. The information that was gathered for all the production lines studied was compiled in matrix format and includes the following variables:

- Degree of mechanization

- Applied control mode (manual, semiautomatic, automatic, or automated)

- Operating Condition

- Layaway--type, condition and documentation availability
- Single station (batch) or continuous process
- Startup documentation availability
- Skills required
- Maintenance practices--operating and followon
- Spare parts inventory
- Equipment--design, age, and adaptability to layaway

The selected line was studied in more detail and data collected for later evaluation. Data requested and collected are recorded in the trip report for each AAP (Appendix C).

Other sources of data included literature searches and discussions with knowledgeable personnel to classify and identify techniques, controls, and equipment used in production facilities.

B. LONE STAR ARMY AMMUNITION PLANT

The primary mission of the Lone Star AAP is to load, assemble, and pack artillery items, rockets, mortar rounds, improved conventional munitions, and components. The plant, located near Texarkana, Texas, is operated by Day & Zimmerman, Inc. Currently approximately 1,200 people are employed as compared with a work force of 12,000 during the Vietnam conflict.

1. Plant Survey. Seven production lines were surveyed and the line for the M557 fuze was selected for study on the basis of its inactive status and machine and control complexity (Table III-1). A brief description of the lines inspected is as follows:

   a. M557 Fuze Assembly Line. The line has a high degree of mechanization, straight-line floating-pallet configuration and a combination of manual and automatic assembly functions. The equipment had been in operation for about 3 years before being idled in 1975. This line was selected for study and was evaluated in detail.

b. M567 Fuze Assembly Line. This is a new line and consists of 13 Honeywell rotary-dial, positive-index assembly machines in series, tooled for the M567 fuze. The output of each machine is automatically loaded into magazines, which are then manually transferred to the succeeding machine. This method of parts transfer adds process flexibility and surge capability to the line. The machines appear to be well designed and built. Preliminary testing and debugging is scheduled to start in April 1977.

c. M28B2 Primer Line. This line was the second to be modernized at Lone Star; it has pneumatic controls and Car-Trac conveyor system. It is of moderate mechanical and control complexity. When surveyed the line had not been in operation for 8 months.

d. 105-mm LAP Line. The modernized melt-pour part of the line is currently under construction and scheduled for completion in 1978. The assembly-pack part of the line has cable conveyors with floating fixtures and mechanized assembling aids for 105-mm ammunition.

e. Delay Detonator Line. There are several identical machines in this line that are the positive-indexing, carrousel type. Each machine has 19 work stations. The machines have never been in production. The equipment condition varies; several have been finished, started up and run for one month; several are almost completed; and one installation has only the machine frame and a few parts that are mounted on the frame or lying on the floor. The individual machines are mechanically complex and have modest control systems.

f. Detonator Primer Line, Rotary Loaders. Jones Loaders of the World War II design and Wheaton Loaders, which were manufactured in the 1950's, are used in this line. They are rotary-table, positive-indexing machines of simple and proven mechanical design. Many manual operations are still required.

g. Detonator Primer Line, Swanson Loader, etc. This line includes several manual bench operations, a black powder loader (M86) that is over 60 years old, and a new Swanson Model FL-12 loader for the M82 primer. The Swanson loader is a positive-index, in-line type that is mechanically complex. At the time of the survey it had been in production only 30 days and was still being debugged.

TABLE III-1

LINE SURVEYED
LONE STAR AAP SURVEY

End Hem(s)	Bldg.	Line Status	Degree of Complexity (*) Mechanization	Controls	Comments
M557 Fuze	M-5	• Operational from 1970 to Dec. 1973 • In layaway since Nov. 1975	6	5	• First modernized line at LSAAP, and first modernized fuse assembly line in the AAP complex. • "Floating pallet," in-line processing. • Designed and built by IBM, debugged by Day & Zimmerman, Inc.
M567 Fuze	K-14	Debugging starts in Jan. 1977	7	5	• 13 Honeywell rotary dial assembly machines, with manual transfer between machines of intermediate-assemblies in magazines • Up to 24 stations per machine; standard Honeywell programmable controls
M28B2 Primer	R-38	Inoperative since April 1976	2	3	• Second line that was modernized at LSAAP. • Pneumatic controls, Car-Trac conveyor system; mechanical complexity only moderate.

TABLE III-1 (Cont)

End Item(s)	Bldg.	Line Status	Degree of Complexity(*) Mechanization	Controls	Comments
105-mm HE Projectile	E-15	Inoperative since 1973	3	2	• Melt-pour modernization to be complete by 1978. • In-line processing; floating fixtures, cable drawn; primarily electrical control.
Detonators (delay type)	P-27	Inactive - never in production	6	1	• Ferguson "Transomatic" loading machine with 19 stations; manual handling of explosives.
Detonators, Primers, etc.	Q-28	Operational	5	1	• Jones rotary loaders.
	Q-29		5	1	• Wheaton rotary loaders; many manual operations.
	R-8	Operational since Sept. 1976 Still debugging	4	2	• Mixture of new and recent machines (such as the Swanson loader for the M82 primer) and many manual operations (e.g., the 1914 vintage black-powder loader for the M-86 primer).

(*) Based on a scale of 1 to 10, with 10 being the most complex.

2. Selected Production Line--M557 Fuze Assembly. The M557 fuze line is a parallel, multiple in-line conveyor system for transporting assembly fixtures into and out of a series of work stations. At each station, a manual or automatic action is performed, and at the final station, a finished assembly is removed. The line was designed to produce 12,000 fuzes per 8-hour shift using 50 people on the line, including supervisors, operators, inspectors, and maintenance-janitorial personnel. Production records revealed that on several occasions the designed production rate was exceeded and from time-to-time a high of 16,000 fuzes was reached during an 8-hour shift.

The M557 assembly line was selected for further evaluation because:

- It had a high degree of mechanization
- It illustrated a combination of automatic and manual assembly operations in a single line.
- It had a 3-year production history
- It provided a basis for comparison with an all-manual line.

Mass-production assembly principles as developed by the automobile industry are evident in the system in that operations are broken down so that each manual or automatic station has a relatively simple duty assignment. The mechanical features in the conveyor floating-fixture system, automatic work stations, and tooling aids in the manual work stations are based on standard design practices. Actuation and control of the machinery is by conventional electric and pneumatic devices, with the pneumatic devices predominating.

SOP 384 describes the system as follows:

> "The Floating Fixture System involves a series of pallets which are coupled to a conveyor. Attached to the pallets by a clutch action are work fixtures. Their function is to hold the component subassembly or assembly in proper position for progressive assembly operations. Although the conveyor travels continuously, the pallet, with fixture, will be disengaged when an obstruction is met. The obstruction will be a hand station or fixture (automatic) station at which there is already an assembly present. The

disengagement action permits the pallet to float or stop at any point between two stations, until the forward pallet is released, at which time the pallet is re-engaged automatically and sent forward. This action prevents movement of any pallet during actual assembly operations, the operator is not rushed, no synchronization of machines stations are necessary and shutdown time periods at a station does not affect the entire line operation. Manual stops, operator controlled are also built into several stations. This provides a reference point for inspection purposes or pallet removal at these stations."

The system consists of three straight conveyor lines. The central and longest conveyor is 182 feet long. There are 29 work or inspection stations on the line. The tail end section of the conveyor is called the rear body line. The head end of the conveyor is designated as the final assembly line. A cleaning station is included after the 25th station. Cleaning is a manual operation and involves removal of any extraneous debris on the conveyor.

The "head line" conveyor is parallel with the central conveyor. The distance between center lines of conveyors is approximately 8-feet. The tail end of the "head line" conveyor is even with the tail end of the rear body line. The unit is 82 feet long, with 14 work or inspection stations on the line and a cleaning station. A transfer conveyor from the last station carries the completed head assemblies to a manual inspection station on the final assembly line where the assemblies are accepted for further assembly operations or rejected.

The "delay plunger" line is parallel to the final assembly line. The distance between center lines of the conveyors is approximately 8 feet. The head end of the delay plunger line is even with the head end of the final assembly line, and the unit is 122 feet long. There are 25 work or inspection stations on the line. A manually operated cleaning station is included in the line.

The total number of basic stations exceeds 70, with 48 designed for automatic assembly of fuze components and equipped with manual override controls. The remaining 22 stations are arranged for manual assembly or inspection.

Air controls and actuators (totaling approximately 5,000 for the complete line) are used extensively.

The system was designed and partly installed by IBM Corporation. Final installation and debugging was done by the contractor-operator, Day & Zimmerman, Inc. The original cost of the line was $1,592,000.

Installation of the line was started in 1968, turned over to Day & Zimmerman in 1969, was in production from 1970 to 1973, and was laid away in 1975.

3. Evaluation. The M557 fuze line is a good example of a mechanized line. The control mode is automatic without malfunction corrective feedback intelligence. The degree of integrated mechanization is evidenced by the continuous-running conveyor, the floating pallets with coupling and uncoupling means, the locating-and-holding pallet fixtures, and the work and inspection stations (manual and automatic).

The mechanized line replaced a manual system that used simple fixtures to produce the fuze. Plant technical operations and personnel, who went through the transition from manual to automatic operation, made the following observations:

- The manual line required 123 people to produce 12,000 fuzes during an 8-hour shift.
- The mechanized line required only 50 people to meet the same production rate during an 8-hour shift.
- The personnel for both the manual and mechanized lines included supervisors, inspectors, operators, maintenance technicians, and janitorial services.
- Using lines (startup with the manual line, then phase in the mechanized line) may be the best means to obtain both a quick startup and a smooth effective transition into full mobilization production capability.

Lone Star AAP technical and operations personnel praised the mechanized line concept and operation. At the time of the line shutdown, material flow and operational efficiency was good and still improving.

4. Layaway Conditions. The production area was clean and uncluttered. The building was weathertight and an automatic dehumidifier was set

to control the relative humidity at 35%. (However, a high of 60% was recorded in April 1976). Observation of the general condition of the equipment indicated that no followon maintenance had been scheduled other than replacement of the dehumidifier recording chart.

The condition of the paint on all machine structural surfaces was fair to good. A light coating of oil (light and medium grade) had been liberally applied to machined surfaces. Surface rusting was not apparent.

The automatic assembling devices on the vertical machine columns were well oiled. The machines were not disassembled to determine the surface condition of precision fitted mating parts. The machined surfaces appeared to be in order. There are 43 similar stations on the three conveyor lines. Informal and incomplete maintenance record books were stored at most of the stations. Rolls of drawings were also found at certain stations. The tool room records appeared to be complete.

The conveyor roller chains and gear boxes appeared to be in good condition. The roller chain and sprockets were well lubricated with a protective oil coating. A total of 239 floating fixture pallets is required for all three conveyors; not all of them were removed from the conveyor. When the gear box and end drive covers were removed, several of the pallets were observed hanging in a random and tipped fashion in the conveyor return tunnel. Those pallets that had been removed were loosely stacked and oiled. No separators such as wood or plastic were used between the pallets to prevent metal-to-metal contact.

The main control system for the line is pneumatic and contains approximately 5,000 individual components. Each automatic station has a control panel for manual control of the air system for that station. The main air line had been disconnected and the service line to the equipment had been removed. Air condensate had been drained and a few air fittings had been disconnected. The panels were not closed and secured. A few panel doors were unlatched and slightly open.

With the exception of the conveyor system, electrical service is minor. Vibrator feed units are electrically powered. The installed electrical service complies with the hazardous specification code and appeared to be in good condition. Bare steel metal parts

on the vibrator feeder mechanical elements were protected with a light oil coat. The bowls were aluminum and not oiled. Electrical panels were left as they were when the machines were operating.

The fuze arming test equipment had been pulled from the line and placed against the area wall at the head end of the conveyors. The units appeared to be in fair condition. Some work had been attempted on the electronic control elements. Electronic tubes and small electrical parts were lying loose on the machine. Apparently work was not completed because of inadequate funding for lay away. Moreover, no written procedure existed for this particular layaway.

5. Impact of Automation/Mechanization on Startup Time. The following estimates were obtained from Lone Star AAP personnel and the KE/ SAI study team concurs:

   a. Startup of the manual line would take about two months with a third month needed to reach full production.

   b. The mechanized line would require about six months for startup plus another two months to reach full production.

   c. These startup-time estimates include time to hire and train personnel.

   It can be concluded that startup time favors the manual line operation over the mechanized line by a ratio of approximately 3 to 1.

6. Guidelines

   a. Versatility of the mechanized line may be substantially increased if automatic stations are so arranged that they can be operated manually. An engineering study is needed to determine the feasibility of a design modification that could reduce startup time or permit operation in the event of power failure.

   b. Basic assembly machine types should be carefully and thoroughly compared to determine which type should be standardized. Machines to be evaluated should include straightline, carousel indexing and rotary-dial indexing. Machine standardization would facilitate the pooling of skills, documentation and spare parts.

c. Automated/mechanized equipment requires that incoming parts and components meet specified tolerances. Compliance to these parameters necessitates that quality evaluation procedures be established and maintained.

d. End item components should be engineered or developed to facilitate automatic manufacture and assembly. This practice will also assist manual assembly.

e. The existing condition of the equipment and the start-up time ratio indicates that the manual line has the greater likelihood of meeting mobilization requirements.

f. General instructions such as TM-38-260 and MIL-STD-107 are not adequate for proper conditioning of modern machinery and controls for layaway, follow-on maintenance, and start-up. New instructions devoted to specific types of machines and specific types of controls elements are required and would supplement layaway, maintenance, and start-up specifications.

g. Layaway and follow-on maintenance should be funded and be performed according to established and updated specifications.

h. Start-up specifications must be established.

C. IOWA ARMY AMMUNITION PLANT

The primary mission of the Iowa AAP is to load, assemble, and pack shells, fuzes, detonators, and miscellaneous component items. The GOCO plant is located in Burlington, Iowa and is operated by Mason & Hanger - Silas Mason Co., Inc. The current level of manpower is 1,400. The level in the Vietnam era was 8,000.

1. Plant Survey. Seven production lines were surveyed, and two lines were subsequently selected as representatives of highly mechanized equipment and associated controls. The two lines chosen for further study are the Warhead Loading Line (relatively complex controls) and the Iowa Detonator-Loader Line (mechanically complex). Both lines selected were operational at the time of the site visit. The line selection and subsequent data collection was a mutual effort between AAP personnel and the study team. The status of seven lines surveyed is summarized in Table III-2, which includes preliminary data evaluation.

2. <u>First Selected Production Line - Warhead Loading.</u> The warhead loading system is a batch operation with a control system that includes manual and computer monitoring. The system includes equipment to melt the Octol explosive, pour the melted explosive into warhead metal parts and then thermally and mechanically control the solidification of the explosive so as to obtain a dense casting without voids. The mechanical vibration of the warehead, while the explosive is still molten, tends to release entrapped air and segrates (to a degree) the HMX component of the Octol mixture. By a computer controlled cycle of separately regulating the heating and cooling of the warhead and its filling funnel (which functionally is a riser), premature freezing in the funnel is avoided and a sound cast explosive is assured in the warhead.

The warhead loading line consists of a single melt unit, a pouring unit, and three solidification bays for the production of shaped charge warheads for the Dragon and the Hawk projectiles. Controls for the melt and pour operations are local, located adjacent to each piece of equipment. Controls for all three solidification or conditioning bays are located in separate control rooms. Each bay has the ability to process 80 warheads per shift, or 240 warheads for all three bays. The warhead loading cycle starts with five warheads being inserted into a cluster of holding and vibrating fixtures so arranged that subsequent pre-heating, pouring, and solidification operations can be performed. The fixture cluster is mounted on a manually portable device that is fitted with casters. Three conditioning bays are equipped to handle the fixture units; each bay has 16 posts with air, steam and cooling water service. The air is used to actuate the vibrators.

An operator loads the empty warheads into the fixtures and couples the steam lines. Then a signal is given to the control room to start the preheat cycle, which is controlled by a direct-digital computer unit. Any error in the temperature setting is noted by the computer, and an alarm is sounded notifying the operator of the error, with the location of the error given for discrepancy correction. When the preheat cycle is complete, a signal light in the control room indicates that the fixture units are ready to be transferred to the pouring bay for the warhead pouring operation. Before the utility lines are disconnected from the conditioning fixture, a "hold" button above each fixture is pushed by the operator, signalling the computer to turn off the solenoid valves, record the time, and start a time-loading sequence for each fixture. When these functions are complete, the computer signals by energizing a "hold" light. The operator then disconnects the utility lines and transfers the fixture units to the pouring station.

The melt pour system is basically a melt kettle and a pouring machine. Octol, a mixture of TNT and HMX explosives, is melted in the doublejacketed kettle with steam and is maintained at the proper pouring temperature hot water. Suspended air in the explosive is removed by vacuum before pouring. An agitator continuously and thoroughly mixes the Octol. Operation of the Kettle is controlled and monitored from a control panel located in the melt bay.

When the Octol is ready for pouring, the fixture unit is transferred to the pouring bay. An automatic pouring machine equipped with five pouring spouts is located directly under the melt kettle. The fixture unit is pushed under the pouring spouts, locked into position, and filled from the reservoir at the pouring machine. Pneumatic level sensors, located next to each pouring spout, control the level of explosive in each funnel. During pouring the warheads are vibrated to ensure proper filling and to release any entrapped air. After filling the warheads, the pouring machine reservoir is automatically refilled with a pneumatic sensor maintaining the proper reservoir level. An insufficient fill condition is eliminated by the automatic pneumatic-logic control.

After pouring, the fixture unit is manually removed from the pouring machine and a conditioning cycle push button activated. This signals the computer to start the solidification or conditioning cycle for that fixture unit. The cycle consists of steam heating the upper and lower members of the fixture unit while the warheads are vibrated. After a preset time, the vibration is stopped and cooling water replaces the steam in the lower member of the fixture unit. The last phase in the cycle is to discontinue the steam in the upper member and continue the cooling water flow in the lower member for a specified time. The solidification time cycle is specified by the particular warhead being processed, with a typical cycle being 5-1/2 hours. When the cycle is complete, the warheads are removed from the fixture units and the pellet cavity drilled or faced, depending on the type warhead, and 100% X-rayed.

The Control room for the conditioning bays includes a Data General Nova 1210 with a 32K main memory, a teletype unit, and a 256K drum storage. Datum Incorporated supplied the electric interfacing and the real time operating system (RTOS). The software, in the Nova 1210 assembly language, was supplied by Mason & Hanger - Silas Mason. The system will accept new weapon programs. Each conditioning bay has the capability of processing either the TOW or

the Dragon warhead during the same shift, by using a selector switch on each console.

In automatic mode operation, the conditioning cycle is monitored and controlled by the process control computer. Any conditions detected during the cycle, except those established for the process, are recorded on a teletype. The control room technicians then takes action to correct any errors. The system can be controlled manually from the control console.

a. Evaluation of Warhead-Load Line. This line is an example of an engineering development that increased production and improved product quality over previous methods. The use of a computer for control is questionable, but the control flexibility designed into the system contributes to efficiency. The warhead load system can be operated by a computer control program or by manual pushbutton.

   Personnel requirements for this line are approximately the same for producing 240 warheads per 8-hour shift as it was for producing only 90 warheads with the manually operated line. Product quality has materially improved; the controlled solidification process has reduced variables in the system, resulting in a more uniform, high-quality product.

   Both the computer system and the melt-pour facility have a greater capacity available than currently is being used in the three-bay facility. They could accomodate five more conditioning bays, which would increase production to 540 warheads per shift. The existing computer hardware, by current standards, is almost obsolete, but the system design principal is sound. The engineering was well conceived and well executed; however, any system with a high dependency on manual labor and human observation for emergency monitoring and corrective action does not warrant computer control, particularly for a simple batch process with a 6-hour cycle time.

b. Layaway Conditions. Because of the system's simplicity and stainless steel construction, few problems are anticipated at layaway time. The exception may be the computer system since layaway procedures do not exist. Start-up should not be a problem because the line has manual control backup.

c. Impact of Automation/Mechanization on Start-Up Time. This automatic system incorporates manual control that permits override of the automatic controls for manual pushbutton operation. Any automatic control malfunction should not impede either start-up or production operation. Consequently, startup should be rapid and effective, as follows:

1. Start-up should be complete in approximately two months.

2. Operator training should not take more than one month. This can concide with taking equipment out of layaway.

d. Guidelines.

1. The design principle that permits manual control to back up automatic control should be applied to other production systems.

2. Newly designed programmable control units for greater simplicity, ease of maintenance, quick replacement, and lower cost should be studied.

3. The practice of controlled solidification casting should be continued.

4. An experimental program should be conducted in an effort to reduce solidification cycle time thereby increasing the rate of production.

5. General instructions such as TM 38-260 and MIL-STD-107 are not adequate for proper conditioning of modern machinery and controls for layaway, follow-on maintenance and start-up. New instructions devoted to specific types of machines and specific types of control elements are required.

3. Second Selected Production Line - Iowa Detonator Loader. The dial-type indexing rotary-table detonator loading line was selected because it is a time proven multiple station mechanized example of compact equipment that can be used as a complete unit or coupled with other equipment to provide an element in a production system.

The detonator loading line is a conventional mechanical design common to industry. The basic structure of the machine is a fixed,

central structure around which a circular table, fitted with locating and holding fixtures, automatically indexes. The center structure acts as both a main machine support, tooling actuator, and a mounting structure for additional tooling, which may be actuator, and a mounting structure for additional tooling, which may be actuated through the circular table indexing motion or by other means, such as pneumatics, hydraulics, cam, or rack-and-pinion mechanisms.

The unit observed was an Iowa Detonator Loader Model 1, designed and built to Mason & Hanger Specifications. The machine is tooled for loading the M55 detonator, with 24 operations required and one detonatorholding fixture at each station. The index work cycle of 1.5 seconds produces 40 detonators per minute. The machine is approximately 5 feet in diameter, and three operators are required for loading, inspecting, and unloading.

a. Evaluation of Detonator-Loading Line. The Iowa Detonator Loader is a practical example of a basic machine type, technically a center column design originally developed for the automobile industry. It is a typical example of production equipment that can be modified and the basic design expanded to accommodate new munitions as they are developed. This type of production equipment can be used well into the foreseeable future. No comparable production manual operation is in existence. Within the capacity of the machine, almost any tooling style of fixture function can be installed on the rotary indexing table, center column, or mounted outside the periphery of the rotary table. The rotary motion of the machine can be used for mechanically actuating fixtures, tooling, and load-and-unload devices or which can be independently operated by other means.

   The compact, proven machine design, ease of tooling installation and maintenance, low number of operating personnel, machine adaptability to fixture and tooling changeover, the capacity to handle a wide variety of parts, and the adaptability of the machine permit it to function as a single unit or to be integrated with either like or unlike machines for a more complex operation. These features indicates machine versatility of considerable scope. While observing the line, occasional machine stoppages occurred, apparently caused by out-of-tolerance components.

   The current series of Model 1 loaders was built to Mason & Hanger design specifications by the Doerfer Corporation of Waterloo, Iowa. The estimated cost today in quantities of three

is $90,000 each. A later version, Model 2, is being designed. It will require fewer operators and have the same production rate (40 detonators/minute). Another design version (Designated Model X-4) with quad-tooling engineered to produce 150 detonators/minute has been proposed for developement.

b. Lawaway Conditions. One detonator-loading machine (the Iowa Loader) was operational during the plant tour and 10 had been in layaway since November 1975. The quality of layaway appeared adequate and most likely was, because these and similar machines have been laid away and reactivated many times in the past quarter of a century. There were no written procedures for layaway of this machine. This extensive experience was also evidenced by the Contractor's specific estimates of time and labor required for layaway; namely, 360 man-hours in a 3-week time period, using two millwrights and a part-time electrician and pipefitter. The estimates appeared reasonable to the KE/SAI study team.

c. Impact of Automation/Mechanization on Start-Up Time. The Iowa AAP supervisors estimated that after a 3-year layaway with good follow-on maintenance, the same number of personnel as required for layaway could start-up an Iowa Loader in 3 weeks.

The Iowa Loader is a compact, proven mechanical design. If properly laid away and maintained, the machine should be readily started up. To duplicate the production rate of 40 detonators per minute by manual means would be impractical.

d. Guidelines.

1. Improvements to the basic machine should be continued.

2. X-Y-Z motion direct powered fixture elements that will mount on the dial table should be developed. With the addition of special locating and clamping fixtures fastened on the direct-powered fixture elements and the rotary-dial indexing-powered fixture elements, the rotary-dial indexing unit can become a universal type machine.

3. Programmable controllers should be studied for practical applications that will permit supplementing or replacing cams or other mechanical actuation means.

4. Probe stations be provided in automatic assembly operations to prevent machinery malfunction.

5. Production components should be re-engineered or developed to facilitate automatic manufacture and assembly.

6. Basic assembly-machine types should be carefully and thoroughly compared from all standpoints to determine which type should be selected for possible standardization. Machines evaluated should include straightline, carrousel index, and rotary-dial index. Machine standardization would facilitate the pooling of skills, documentation, and spare parts.

7. General instructions such as TM-38-260 and MIL-STD-107 are not adequate for proper conditioning of modern machinery and controls for layaway, follow-on maintenance, and start-up. New instructions devoted to specific types of machines and specific types of control elements are required and should be generated.

D. RADFORD ARMY AMMUNITION PLANT

The primary mission of the Radford AAP is to manufacture propellants and explosives. The GOCO plant located in Radford, Virginia, is operated by Hercules, Inc. Original production facilities at Radford were constructed during World War II and have since gone through a series of layaways, rehabilitations, and reactivations necessitated by the cyclic requirements for their end products. The current level of manpower is 2, 400. The level in the Vietnam era was 9, 500.

1. Plant Survey. Radford AAP was initially surveyed by the study team to determine the current status of production lines. Six production lines were examined. Table III-3 summarizes the status of those lines. The continuous, automated, single-base propellant line was selected for further study as it was representative of highly mechanized equipment and associated controls. The other lines (primarily acid) reviewed are essentially standard type industrial units with fewer start-up problems. However, an operational problem confronting Radford is the required periodic operation of the acid lines. One month of operation and 3 to 4 months shutdown is the typical cycle, and Volunteer AAP has the same problem. This intermittent operation is caused by the disparity of production rates. The acid lines are not designed for other than full production and cannot meet reduced usage requirement. The frequent shutdowns of the Oleum (SAR) line quickly deteriorates the refactory lining of the high tem-

perature reaction furnance ("boiler") creating excessive maintenance. This situation emphasizes the need for flexibility in a munitions production facility, and the recognition that design criteria for equipment to be used in those facilities often must be modified to meet the peculiar needs of the munitions industry (namely, intermittent operation).

2. <u>Selected Production Line-Continuous, Automated, Single Base Line.</u> The continuous, automated, single base propellant line selected for the study analysis is replacing a 1941 vintage batch type line. The automated line apparently promised potential major advantages, including greater safety, a more uniform product, and over 70 percent reduction of manpower (from 364 to 96). Design capacity is 1,250 tons/month of M6, M1SP or M1MP single base propellants. Plant completion and start of the proveout and acceptance phase are scheduled for the spring of 1978. At that time according to Radford personnel, the investment is expected to total $48 million and current cost estimates for the Proveout and Acceptance operation is $6 million.

The manufacture of a single-base propellant by the solvent process consists of dehydrating nitrocellulose and mixing it with chemical ingredients and solvents, convering the bulk-plastic propellant mixture into grains, and drying, blending, and finishing the propellant grains. The propellant usually contains between 88 and 98 percent by weight of nitrocellulose.

The process has been separated into three distinct operational buildings (granulating, drying, and packaging) plus a separate and isolated control building. Two parallel lines carry the raw material through processing to the finishing building. There is no surge capacity in the system.

The entire process is remotely controlled, utilizing a Foxboro PCP-88 computer with two Digital Equipment Corporation PDP-8/1 minicomputers and peripheral equipment. Control will be supplemented by placing TV cameras in several key areas and using roving technicians throughout the production areas. Samples of in-process material will be manually extracted and carried to a nearby test laboratory for analysis.

The operational mode uses direct digital control (DDC). One computer functions as the control processor and performs the DDC operations, sequential control communication functions,

and system security monitoring. The second computer functions as the supervisory processor; however, it is normally used for off-line functions such as data logging, supervisory control, and plant engineering functions. In the event of a failure of the control processor, the supervisory processor assumes the control functions. The system has over 300 analog input sensors and nearly 100 DDC loops. Final control devices are principally electric and pneumatic motors and valves. The computer software is still in the process of development and debugging. Although industrial-type analog process controllers exist (mounted on free-standing panels) for performing manual set-point control, funding constraints permitted their inclusion as on-line backup to the DDC system for only a limited number of process-control loops.

3. Evaluation. According to the Foxboro Company, approximately 50 PCP-88 computer systems were sold worldwide between 1967 and 1974, when production was discontinued. Numerous refineries and five U.S. Army facilities (Radford, Volunteer, Joliet, Indiana, and Picatinny) purchased the systems. These DDC computer systems are particularly well suited for refineries where there is the need to respond to varying composition of their input material (crude oil) and still meet the demand for different products (output fractions). However, processes with fixed inputs and outputs, such as the production of TNT with the constant nitric acid and nitrocellulose input and TNT output does not appear to favor the more complex computer control over the simpler analog type of process control.

Although some of these PCP-88 systems have been in continuous use for 10 years, Foxboro still prefers not to forecast their life expectancy. A 10-year life appears reasonable for a component of most munition production lines; however, a 10-year projected life is 10 years after date of manufacturing that computer, not necessarily years of usage. The manufacturer belives (but has no backup data) that maximum life is attained by keeping the computer energized and continuously cycling a sample program. They also recommend that temperature and humidity be controlled during inactive or layaway periods and the storage of computers in sealed containers should be avoided, because of the outgassing of some of the plastic parts. When questioned by Computer Sciences Corporation (who conducted a study on computer layaway problems for Picatinny Arsenal in 1975), Foxboro estimated that a meaningful engineering study to determine the

layaway problems of a particular series of computer would require a $60,000 funding effort. This proposed research was not funded. Foxboro also volunteered the following information:

- A user should expect to replace many of the process sensors (transducers) after a layaway, particularly if they had been exposed to acid.

- Wiring is occasionally damaged by rodents.

- A change of computer series usually requires new software programs.

Not all manufacturers of process controllers agree with Foxboro. Several believe that continuous operation of a computer is not necessary or even desirable for maximum life. Further investigations of this problem appears warranted. Production availability of the continuous automated, single-based line is suspect in that there are a multiplicity of process operations in series without surge capacity.

The DDC controls lack 100% operational backup. Funding cuts forced Radford personnel to eliminate a substantial portion of the analog type of process controllers, which would have been the backup for the DDC control mode. Operation by manual control is not considered feasible because of the process complexity. Availability of spare parts for the Foxboro PCP-88 computer is potential problem, as Foxboro's policy is to stock computer spare parts only for period of five years after production cessation of a particular type of computer. The PCP-88 product line was discontinued in 1974 and thus spares will no longer be manufactured after the year 1979; the year the single-base line is scheduled to start production.

Radford's formalized training programs are limited primarily to the subject of safety. Application training for operators, maintenance and engineering personnel is the on-the-job type. However, future operators of their CIL-type of TNT lines (currently being rebuilt) could possibly benefit from Volunteer AAP's developed CIL training program.

4. Layaway Conditions. Installation of equipment and control is still in progress. On-site observation indicates that proper layaway of this line will be difficult and costly, particularly if the idle period is of appreciable length (e.g., more than 3 years)

The multiplicity of process operations in series, the control complexity, and the subsequent skill requirements will make the start-up of this line particularly difficult.

5. Impact of Automation/Mechanization on Start-Up Times. If the continuous, automated single-based propellant line is debugged in the 1978-1979 period and laid away for any extended period of time (more than 3 years), then a startup time even close to mobilization requirements (M-3) should be expected only if planning and execution for the following have been throrough:

- Layaway
- Follow-on maintenance
- Startup procedures
- Provision for or assurance of spare parts at time of startup
- Skill retention
- Modification of the controls to provide 100% backup by analog controllers of the DDC system.

Table III-4 summarizes the estimated start-up times for various conditions, and is based upon the assumption that the line has been debugged and laid away for a period of three years. It should be noted that startup procedures should be prepared when the line is operating, as personnel capable of writing such procedures may not be available at time of startup.

6. Guidelines.

- Establish a positive skill-retention program, whether in the form of a nucleus of experienced personnel or of a total-documentation type of training program.

- Controls should be supplemented to provide 100 percent analog backup to the DDC system.

- Current computer, minicomputer and microprocessor technology should be studied for possible replacement of the present computer unit.

- General instructions such as TM 38-260 and MIL-STD-107 are not adequate for proper conditioning of modern machinery and controls for layaway, follow-on maintenance, and startup. New instructions devoted to specific types of machines and specific types of control elements are required.

TABLE III-4

ESTIMATED STARTUP TIMES FOR
CONTINUOUS AUTOMATED SINGLE BASE LINE
AT RADFORD AAP

Conditions				Startup Time, Months	
A	B	C	D	w/DDC Control	w/Analog Backup Control
O	O	O	O	4 to ?	4
X	O	O	O	6 to ?	6
O	X	O	O	6 to ?	6
O	O	X	O	12 to ?	8 to 10
O	O	O	X	4 to?	4

A = layaway and follow-on maintenance
B = startup procedures
C = skill retention
D = computer spare parts availability
Condition O = OK; a thorough job done
Condition X = inadequate or nonexistent

E. VOLUNTEER ARMY AMMUNITION PLANT

Volunteer AAP is an explosives manufacturing plant that is owned by the Government and operated by a contractor, ICI United States, Inc. (formerly Atlas Chemical Industries). The plant is located in Chattanooga, Tennessee, and has a personnel level of 500, compared to a high of 2,600 during the Vietnam War. The history of the plant can be summarized, as follows:

Date	Event
1941 to 1946	16 manual TNT batch lines built and operated.
1946 to November 1952	In layaway, with good interim maintenance.
June 1953 to 1957	Operating

Date	Event
1958 to September 1965	Inactive, no interim maintenance; for example, entire 1960 budget of $350,000 required for security and fire protection.
Sept. 1965 to Mar 1966	6 months and $28 million of reactivation funds to initiate manual batch-line production.
Mar. 1966 to Feb. 1975	An additional line was activated each month until 10 lines were operational. Two lines were lost and the eight remaining were shutdown (but not laid away) in 1975.
1974 to present	Six continuous Canadian Industries, Ltd., (CIL) lines built, one operational.

There are currently 7 manual batch lines that are potentially usable, and six continuous lines, one operational, the others near completion and layaway.

As indicated above, the original TNT batch lines were inactive and without maintenance from 1958 to 1965. The lack of maintenance plus the carbon-steel construction of the TNT equipment necessitated an expenditure of $28 million of 1966 dollars to reactivate 10 of the batch lines plus ancillary acid lines in an M+6 time frame for initial production. Reactivation criteria included a service requirement of only 2 years. On a crash program of this nature, the cost obviously was excessive by normal standards, as indicated by the following excerpt from Appendix H. "Progress of the work in the field has been most controversial. At one of the weekly review conferences in October, it was estimated that a labor force of 610 men would be required; this has risen constantly, and in late January the actual field force was 1,584." An analysis of some of these previous reactivations or startups would likely reveal the additional costs attributable to inadequate layaway and follow-on maintenance and little or no startup planning. Such a breakdown was not available for the Volunteer AAP reactivation in 1965-1966.

1. Plant Survey. Six continuous CIL production lines have been built at Volunteer AAP, using almost identical stainless steel equipment but with different controls. They are all housed in permanent

buildings. The production capacity per line per month is 1,500 tons of TNT. The labor required is 6 men per line per 8-hour shift, as compared with the 16 to 18 men required for the old manual batch lines. A brief summation of the six lines is presented in Table III-5.

TABLE III-5

CONTINUOUS LINES SURVEYED AT VOLUNTEER AAP

Line No.	Control Type[a]	Status
1	Direct digital control with remote/manual backup	Operational since Nov. 1974; good production since Oct 1975
2, 3	Local/manual	Cold checking starts Jan. 1977, then will be shutdown; manual withdrawal of samples, and manual dumping
4, 5, 6	DDC with analog and remote/manual backup	Automatic sampling and titration

[a] The manual controls have fixed set points, and "local" means that the operators are in the same area as the nitration and purification equipment.

A reliability and safety deficiency of the production facility was revealed during the KE/SAI study team's visit to Volunteer, when the main on-site transformer (single installation) for the facility was lost, because of an insulator failure. The cause of the failure was attributed to a combination of moisture retention and freezing temperatures. A proposed installation of a second transformer for standby had been recommended but never funded.

A spare transformer would improve on-site power-system reliability, but would not guard against a power supply system failure. It appears that an on-site, local-generator standby or emergency power source sized to service critical operations and to satisfy safety requirements should be considered.

Preliminary calculations indicate that power requirements of a single, operating TNT line (including acid-fume recovery and load-out, but not the acid plant) is less than 1,000 kVA. Cost of a 1,000-kW diesel-powered generator is $110,000. Cost of a 10,000 kVA standby transformer would be approximately $70,000. Either action appears prudent in view of the capital investment and readiness posture involved.

As at Radford, the intermittent operation of the acid lines at Volunteer creates excessive maintenance. This is caused by the disparity in minimum output of the acid lines and the requirements of the TNT line. For example, a single acid line (Oleum) producing 550 tons/day can supply an entire month's requirement of acid for the TNT line in just 5 days.

2. <u>Selected Production Line--TNT Continuous Lines.</u> Being the only modernized end item production lines at Volunteer AAP, the TNT continuous lines were evaluated in depth. TNT is manufactured by the CIL (Canadian Industries, Ltd.) process, in which toluene is nitrated with nitric acid, using Oleum (100% sulfuric acid plus absorbed CO_3) both as the nitration catalyst and as the absorber of the water of nitration. The chemical reaction occurs in a continuous, progressive manner.

Toluene is first reacted with weak nitrating acids at moderate temperatures to form mononitrotoluene. The reaction then proceeds through binitration (dinitration) and trinitration, during which acid strengths and nitrating temperatures become progressively higher, to produce crude TNT.

The nitration step takes place in six nitrator separator stages; the first and third stages have two nitration vessels per separator, and the remaining four stages have only one nitration vessel per separator. Extensive instrumentation permits monitoring of the temperature in all nitrators; the fail-safe system provides automatic shutdown of the feeds if a nitration temperature passes outside a preset temperature range. Since nitration proceeds continuously there is little unreacted material in the nitrators at any time, and nitration stops soon after the feeds are stopped. However, if the nitration temperature rises above a preset point, the contents of the nitrators and separators are automatically discharged into drowning tanks.

The purification of the crude TNT is carried out in the molten state by first passing the TNT through a mixer-settler unit. This provides five separate, countercurrent water washes to remove acids. After initial washing, the TNT is treated with sodium sulfite (Sellite) in two steps to remove undesired TNT isomers. The beta and gamma isomers of TNT, containing the reactive metanitro group, are removed by reaction with Sellite. The sodium salts of dinitrotoulene sulfonic acids, formed by the Sellite reaction, are water-soluble. Finally, the TNT is again washed by a countercurrent flow of hot water and transferred by pump to the finishing building.

Purified TNT from the nitration and purification building is piped into the finishing building as a water-TNT mixture. Water is separated from the TNT and is returned to the nitration and purification building.

The molten TNT flows from the separator to a hold tank and then to a steam-jacketed drier, where drying is effected by bubbling air through the molten TNT. From the drier, TNT flows through a screen into a storage pan under a rotating flaker drum. The flaker drum picks up a thin layer of molten TNT, which solidifies on the drum as it rotates. The solidified TNT is cut off the drum in small flakes by a doctor blade. The flakes fall into a hopper and are loaded into 50-pound boxes for shipment.

3. Evaluation. The direct digital control (DDC) systems used for lines 1, 4, 5, and 6 are almost identical to the DDC system in Radford's continuous single-base propellant line. Because the numbers of process operations in series for a TNT line are relatively few and because the inputs and output are constants, it appears that the value of the computer control system is marginal for this application, particularly in view of the problems of remaining life expectancy and spare parts availability. However, when a DDC system is used with analog and manual backup controls (as lines 4, 5, and 6), then reliability and ease of startup are not reduced and little additional money has been expended. Total of all six TNT lines at Volunteer was $43 million, of which all control systems were only $2.3 million.

A commendable aspect of the modernized TNT production base is the near-standardization of process and equipment with other plants (see Table 3-6). This commonality should produce many benefits

such as the sharing of operating experience, equipment improvements, and training programs, all of which help to reduce startup time.

TABLE III-6

COMPARISON OF MODERNIZED TNT PRODUCTION BASE

AAP	No. of TNT Lines	Comments
Volunteer	6	See Table 3-5 for data.
Joliet	6	Installed 1974; only mannually controlled lines (3 of the 6) proven. Proveout of a line with DDC system scheduled to start April 1977.
Radford	2	Lines B & C are being rebuilt with analog plus local manual controls.
Newport	5	Inactive. Local-manual control.

Volunteer AAP personnel estimated that startup (and the study team concurs) of one of the continuous CIL lines would require approximately 3 months, with an additional 6 weeks to achieve in-specification production. Startup of one of the old, manual, batch lines would require 6 months because of their poor condition.

These estimates assumed the following:

- Availability of a nucleus of experienced personnel.
- All pending modifications completed before layaway.
- Proper layaway
- Maintenance during layaway. Note that multiple, unrepaired failures in the digital controls become increasingly difficult to correct, because the computer is used in diagnosing its own failures.
- Availability of spare parts at time of startup.

The opinion of Volunteer personnel was that either continuous-line 2 or 3, with local manual control, would be chosen for initial start-up (assuming all lines are shutdown), since those lines provide visual observation of material-in-process, and thus accelerate operator training. Color indicates the degree of nitration at various stages in the process, and thus is a valuable supplement to the operators' instrumentation.

(If this is so, then it would seem logical from a safety standpoint to replace visual observation with additional instrumentation and move those operators to a remote location).

Of the five AAP's visited by the study team, only Volunteer AAP has organized a formalized and professional training program for operators, with manuals, slides, films, exams, and training simulators (e.g., controls). The training program for the continuous TNT line lasted 10 weeks, and the supervisors took the course with their men.

The courses trained operators for the following:

- Continuous TNT
- Support Lines
- Direct strong nitric (DSN)
- Ammonia oxidation plant (AOP)
- Sulfuric acid regeneration (SAR also termed Oleum)
- Acid fume recovery (AFR)
- Industrial liquid waste treatment

It was estimated that the cost to prepare the operator training program was less than $300,000. Were this program expanded to include training preparation for maintenance and engineering personnel; development of layaway, follow-on maintenance, and startup procedures; and thorough, up-to-date records in the areas of operating procedures, equipment experience, and tooling, then the Army would have a total-documentation package, applicable to all similar plants, to solve the skill-retention problem. The additional cost would be $300,000, or a total cost of $600,000 which is less than 0.2% of the value of the 19 TNT lines and their supporting lines. (Over 300 million in 1970 dollars).

If such a total-documentation package is not achieved, then it is essential that a nucleus of personnel with prior operating experience

is retained. The number of experienced personnel available to form this nucleus in the future will be drastically reduced, because of the decreased number of operating personnel required per line.

It was pointed out by Volunteer personnel that (1) each TNT facility has its own operating practices (e.g., control set points), and (2) it may be possible to increase the TNT yield from a given quantity of raw materials by optimizing the variables (e.g., concentrations, temperatures, flows). No study of this nature has been made to date.

Since the CIL equipment in all four TNT plants is virtually identical, it should be practical to standardize the process and extend documentation and pooling of skills.

4. Layaway Conditions--TNT Continuous Lines. None of the six lines was in a layaway status, and no layaway procedure had been prepared.

   On-site inspection was made of all or part of three lines. The processing areas of all the lines were essentially the same.

   The facilities are well constructed and should protect the equipment during layaway. Most of the equipment tanks, piping, valves, etc., are of stainless steel. Other elements in the system, if properly treated, should not materially deteriorate over a reasonable (up to 5 years) layaway period.

5. Impact of Automation/Mechanization on Startup Time. Volunteer AAP personnel estimated (and the study team concurs) that startup of one of the continuous CIL lines would require approximately 3 months, plus an additional 6 months to achieve inspecification production. Because of the poor condition of the equipment, startup of one of the old, manual batch lines would require about 6 months, including replacement of eroded carbon steel vessels, piping, valves, etc.

   These estimates assumed the following:

   a. Availability of a nucleus of experienced personnel or completion of a total documentation package.

b. All pending modifications of the continuous lines completed before layaway.

c. Proper layaway.

d. Proper follow-on maintenance.

e. Manual controls would be used during the startup phase. Consequently, any computer problems would not delay startup.

6. Guidelines.

a. The process should be optimized to increase yield.

b. Analog control should be added to TNT Lines 2 and 3.

c. The reliability of electrical power services must be ensured.

d. The operator training program prepared by Volunteer should be expanded to include all personnel who are involved with the operation. Further, it should be incorporated into a total-documentation package that can directly serve other continuous CIL TNT manufacturing plants (e.g., Joliet, Radford, Newport). Moreover, it could be used to test the effectiveness of this means of providing skills retention as an alternate to experienced personnel. Should this concept prove satisfactory, other munitions plants could adapt it to suit their particular needs.

e. Visual operations should be replaced with additional instrumentation and the operators moved to a safe location.

f. Current programmable control units with manual, remote backup capabilities should be evaluated.

g. It is essential that the documentation package be kept up-to-date.

h. Close contact should be maintained with other AAP's that manufacture the same product. An open exchange of ideas for product and operating improvement should produce a standardized quality product.

i. Layaway, follow-on, and startup procedures must be tailored to suit the characteristics of the continuous CIL TNT manufacturing process.

F. SCRANTON ARMY AMMUNITION PLANT

The Scranton AAP located in Scranton, PA, had been converted from a railroad maintenance shop to a projectile metal parts manufacturing facility in 1953. Chamberlain Manufacturing Corporation became the contractor-operator in 1963 and is currently producing 155-mm M107 projectile bodies at a rate of 24,000 per month. The plant also has the capability of producing 175-mm and 8-inch projectile bodies. Capacity output at mobilization would be 200,000 projectile bodies per month. Plant and equipment modernization has been underway since 1968. The current contractor personnel level is 480, as compared to 1,800 during the Vietnam conflict. The manpower level in 1968 was 1,800.

1. Plant Survey. The Scranton AAP was visited to determine the cur- status of production equipment, both operating and in layaway, and to evaluate the mechanization and control applications. Table III-7 summarizes the manufacturing operations and equipment. The new and unused machining equipment for the 175-mm and 8-inch projectile bodies was being placed in layaway in accordance with standard government practices.

2. Selected Production Line: 155-mm M107 Projectile Body. The manufacturing process consists of an integrated flow from raw product, in billet form, to the finished painted projectile bodies, complete with rotating bands and lifting eyes, strapped on shipping pallets.

3. Evaluation. Automatic load-and-unload shell transfer devices are being installed with a new rough turn system. These features are intended to reduce operator fatigue and lessen chance of worker injury. An automatic chip disposal system is a part of the new operation.

   The plant equipment is conventional and made to standard industrial specifications. Some transfer position (out of phase) problems were observed in the operation of the transfer machinery (automatic loading and unloading devices, transport conveyors, etc.). This is normal in an integrated system of this magnitude where the workpiece weighs about 100 pounds and many chips are generated. Once the debugging is completed, the operation should be smooth, efficient, and reliable.

Table III-7
FACILITY AT SCRANTON AAP

Process Operation	Equipment	Part Status
		Billet
Notch & break	Torch & press	
		Slug, cold
Heat to forge temp. (n2200f)	Rotary furnace	
		Slug, hot, w/scale
Descaling	Water-jet descaler	
		Slug, hot w/o scale
Cabbage, pierce & draw	Forging presses	
		Cylindrical forging, hot
Cooldown	Conveyor	Cylindrical forging, cold
Shot blast - ID & OD	Abrasive cleaner	
		Cleaned forging
Rough machining	155mm lathes, etc. / 175mm lathes / 8"lathes etc.	
		Rough-machined forging
Heat nose to n1500F	Induction heater	
		Rough-machined forging. hot
Forge nose	Press	
		Forged-to-final-shape part
Heat treat	Furnaces, quench tank	
		Hardened part
Shot blast ID	Abrasive cleaner	
		Cleaned part
Finish machining	155mm lathes, etc. / 175mm lathes / 8"lathes etc.	
		Finish-machined part, w/o band
Band swage	Swaging machine	
		Finish-machined part-w/ unmachined band
Machine band	155mm / 175mm / 8"lathes	
		Finish-machined part
Weld on base plate	Welding machine	
Surface treat & paint	Cleaning & painting lines	Finished projectile body.
Pack, inspect		

Lathes on one of the two modernized rough-tuning lines for the 155 mm forging were procured from Detroit Broach (division of Babcock & Wilcox), lathes for the other line were separately procured from Jones & Lamson (division of Textron). It is suggested that the benefits of equipment standardization, both within and among plants, be incorporated when purchasing equipment. Benefits include a probable reduction of initial procurement cost and an appreciable reduction in training, maintenance, layaway, and startup problems. ASPR Section I, Part 15 described the use of options for procurement. For example, had the Invitation for Bid for the first procurement of lathes for Scranton's rough-turning lines included an option requirement, permitting the Government to purchase additional lathes at a specified price and within a specified time period, then the Government could have (a) purchased the additional lathes when funds became available, (b) avoided the unnecessary paperwork of a second round of bidding, (c) achieved standardization of that equipment and (d) most likely procured all of the lathes at a more competitive price.

4. Layaway Conditions. The automatic equipment now being installed is not unduly complex and should not present any layaway problems. The various elements in the system are basically standard; personnel skills required are those common in modern, mechanized, metal-working production operations.

5. Impact of Automation/Mechanization on Startup Time. Assuming that the 155 mm line will have been completely debugged before initiating layaway production and practices, it is estimated startup could be achieved in approximately 4 months. The 175 mm and 8-inch lines were laid away without operational debugging and accordingly, startup time would be some period greater than 4 months.

6. Guidelines.

   a. Develop gages for 100% automatic inspection.

   b. Develop layaway, follow-on maintenance and startup documentation.

   c. Develop and document a comprehensive training program for supervisors, machinists, operators, inspectors and production maintenance personnel.

IV. GENERAL DISCUSSION

A. EQUIPMENT AND PRODUCTION LINE DESIGN

The evaluation of the six selected production lines indicated that the engineering incorporated the latest "state-of-the-art" or technologies into equipment or production lines without careful evaluation of the need. For example:

1. The use of direct digital control computers for continuous TNT lines at Volunteer and Joliet AAPs for only process control is questionable. Analog controllers with remote manual control would provide a more versatile control capability.

2. Air controls and actuators on the M557 fuze assembly line at Lone Star AAP number over 5,000. It was evident that little consideration was given to preventing problems that could arise in layaway, follow-on maintenance and startup.

3. Modernized/automated/mechanized concepts do not necessarily mean continuous process lines. Batch lines can be automated and may satisfy production layaway and production requirements. See Appendix G for an example.

B. AUTOMATION/MECHANIZATION APPLICATION

1. General. Because of the human element, manually-operated controls introduce the maximum number of variables. The addition of semi-automatic controls lowers the "attention" requirement of the human operator but the burden of overall control is still his responsibility. Automatic control strives to smooth out process operation for highest efficiency but still requires human re-programming when tolerances are exceeded. Automation compares the value of a controlled condition with a desired value and corrective action dependent on the difference is taken without human intervention. Rarely is a munitions line completely automated but, rather, is a combination of all the control modes.

2. Process Control. The munition production lines that can generally be classified as "process", manufacture propellants and explosives. "Process" generally relates to chemical reactions which depend on control of liquid, gaseous (and sometimes powder) flow, temperature, pressure, chemical analysis, etc. Industrial type process

controllers (analog) provide individual automated loop control. If a difference exists between the measured variable and the set point, an error signal is converted to a corrective action to reduce or minimize the difference. Process stability exists when the controlled variable is maintained nearly equal to the desired value. The speed of the process recovery to a stable condition (corrective step) is a measure of the success of the control system. Sometimes each loop is under the overall guidance of a central controller (computer for set point control, a sequence controller for operation step control). Both the computer (for this type of application) and the sequence controller rely upon the process controller for any needed control action (off-on, proportional, proportional plus reset, and rate or derivative action). When required, direct digital control is available utilizing special sensors or input-output translators and a programmed digital computer.

3. Mechanization. Mechanization is generally related to material handling automated assembly systems and machining operations including forging and heat treating and cleaning and surface treatment. Numerical type controls and the application of solid state logic devices permit great flexibility in controlling both simple and complex operations - machine indexing, part transfer, movement etc. Preprogrammed sequence controllers are used to initiate the many machining steps, and each succeeding step is initiated in response to a positive indication that the preceeding operation was completed. If gaging, automatic or manual, indicates an out-of-tolerance condition or an expanding tolerance drift trend in an automatic machined sequence and there is no feedback corrective control, human reprogramming of the machine controls is required. If there is automatic monitoring and automatic correction of tolerance drifts, that phase or step in a production line is automated, and the speed of operation and the number of controlled complex steps determines the degree of mechanization.

C. LAYAWAY AND FOLLOW-ON MAINTENANCE

After each plant survey was completed, it became apparent that the misapplied overly complex machines and machine control elements can affect startup time; however, these deficiencies are not the main cause of the delay in our estimate of time for reactivating munitions manufacturing systems. Mediocre to poor equipment layaway conditions are the major cause of startup difficulty. The poor conditions noted are as follows:

1. Services and supply lines to laid-away equipment are neglected. Piping, valves, meters, control devices, electrical service, steam, water, oil and compressed air supply systems could corrode, rot or deteriorate after long periods of storage. Preservation methods utilized are insufficient and follow-on maintenance is not scheduled to assure adequate parts replacement.

2. Plans for systematically preparing idle lines for layaway do not exist. Evidence of cannibalization of idle equipment was observed.

3. Scheduled maintenance of idle equipment or ongoing lines is lacking.

4. Layaway documentation for lines to be laid-away or in layaway do not exist in total. Scattered bits of information are available but not organized.

The passage of time produces insidious deterioration of an idle plant, which is unavoidable and largely unassessable until reactivation is undertaken. Gaskets, seals, and packings can harden and become useless. Unprotected equipment breathes with temperature and barometric changes and is invaded with dust and moisture that leads to corrosion. Structural settlement produces equipment misalignment. Brick furnace linings shrink and swell, resulting in cracking and spalling. As the duration of layaway lengthens, the problems of rapid startup are increased and the mobilization short time response capability becomes increasingly questionable.

AMCR 235-1 recognizes high, medium and low states of readiness as designating three separate conditions of response for reactiviation. Applied to idle lines in operating plants, the terms are meaningful only if funds are made available to support the appropriate scale of continuous maintenance. When an entire plant is put in layaway, the terms become somewhat inapplicable. The reactivation time required for such plants depends on the layaway procedure, the nature of the process to be reactivated, and the amount and kind of maintenance which has been afforded during layaway. For example, facilities programmed for M + 4 response must be laid-away with allowance for that schedule, and must be given continuous active maintenance during the layaway period.

D. FUTURE CONSIDERATIONS

1. The current method of cost justification for munition plant equipment is in error because it is predicated on full production for a

determinate period of time. The true economic key is operational and maintenance cost. Payback does not really occur when applied to indeterminate production and layaway periods. In addition, planners tend to misinterpret modernization which can apply to refurbishment and replacement as well as new installations. Private industry is geared to full production on a continuous basis while munitions plants must meet full or partial production schedules for indeterminate periods of time and shut down for extended periods when ordered. The application of advanced technology to production or processing line equipment for munitions manufacture requires a different approach. The emphasis has to be on the simplicity of operation, with machinery and control elements engineered to withstand the detrimental effects of environment while in layaway, and capable of rapidly achieving either minimum or maximum production rates when activated.

2. When the simplicity of operation includes, as required, a degree of automation/mechanization, the degree must be evaluated in terms of safety constraints, ability to protect the equipment while in layaway, availability of future spare parts and compatibility with manual control.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. There is a lack of communications between AAP facilities with similar technologies. The five producers surveyed apparently do not communicate with similar AAPs to coordinate equipment and adapt standardization where it would serve a common purpose.

2. The least sophisticated equipment that would provide adequate performance is not employed to the maximum extent; and, as a whole, equipment used appears to have been chosen because it was more readily available rather than because it fitted precisely a need.

3. An estimate of the relative (as compared to the superseded line) startup time requirements for the six lines studied is as follows:

Plant	Line	Relative Startup Time
Lone Star	M557 Fuze Assy	Increased
Iowa	Warhead Loader	Same
	Detonator Loader	Same
Radford	Single Base Propellant	Increased
Volunteer	Continuous	Same
Scranton	Projectile Body	Same

The startup time evaluations are based on the following conditions:

a. Skills are available
b. Layaway has been conducted properly
c. Equipment has been maintained properly
d. Startup planning documents are available

Poor layaway practices are the prime contributor to the estimated startup time increase at Lone Star AAP. Radford AAP has a different problem; the equipment complexity and control inadequacies will increase startup time.

4. The only significant example of process and/or equipment standardization observed at the five GOCO plants visited by the study team was the continuous TNT lines at Volunteer AAP.

5. Several GOCO production lines/facilities (e.g., the Oleum lines at Radford and Volunteer) lack the capability to operate at reduced production rates; i.e., they can produce only at design (maximum) rate or not at all.

6. The interservice layaway manual, TM-38-260 is an obsolete document and does not provide complete layaway guidance.

7. The survey of the production lines in layaway at the five assigned GOCO plants revealed that layaway and follow-on maintenance is marginal to inadequate and will have a negative impact on startup costs and startup times. The stated reason for inadequate layaway and maintenance is lack of funding.

8. Except for an operator's training program at Volunteer AAP, the five plants surveyed do not have skill retention programs, whether in the form of retaining experienced personnel or a total documentation training program. Such programs are essential to a successful startup.

9. Procedures for layaway, follow-on maintanance, and startup applicable to specific equipment/production lines were not found at any of the five surveyed plants.

   Equipment that is to be used by the munitions industry should, unlike its counterpart in general industry, be designed to be compatible with layaway and startup requirements. There is little evidence that the special requirements of layaway and startup had been considered in the design of the special equipment.

10. The control system design for the continuous single-base propellant line at Radford AAP and the continuous TNT lines at Volunteer AAP indicate that insufficient engineering effort has been spent in the following area:

    a. Operating life expectancy of controls

    b. Obsolescense expectancy in computer and peripheral electronic equipment

output can be provided. Another design might consist of two production lines, again controlled from the same control station, one line for mobilization needs, the other for peacetime schedules.

Either installation will permit layaway of part of the system while the control function can be maintained in a "go" condition. Additional benefits will include operating personnel "know-how", operator training opportunities, and rapid startup from layaway.

6. TM-38-260, "Preparation of Industrial Plant Equipment for Storage and Shipment", should be updated. Obsolete, obscure, and incomplete information should be deleted, clarified, or completed. Any other manuals currently in use should be combined with it to form a general, up-to-date instruction manual for the protective storage of facility and facility service lines, machinery and tooling, pneumatic and electrical controls and computers, and peripheral electronic equipment. In addition, specialized production or process equipment or lines may have certain characteristics that demand special layaway, follow-on, and startup instructions. In such cases, specific directions should be prepared as a supplement to the general manual. A continuing program to keep the manual current should be established. A system of replaceable instruction sheets might be developed for that purpose.

7. The original procurement funding for munitions production equipment should include funds for a total document package. The package should contain layaway, follow-on maintenance and startup instructions, up-to-date engineering drawings and specifications of the equipment and the facility and facility service lines, history and servicing record of the operation, and a comprehensive training program for <u>all personnel</u> associated in any way with the system. Duplicates of the data necessary to startup, train personnel, operate, and maintain the equipment and facility should be laid away with the equipment. Additional copies should be readily obtainable from production engineering, plant central control, ARMCOM, etc. In addition, a supply of production parts should be included with the layaway to expedite startup.

8. Skill retention generally relates to the availability, when needed, of personnel who have a practical familiarity with munitions manufacturing. Sufficient numbers of "on hand" or readily obtained experienced people should be able to rapidly effect an orderly startup. However, long periods of equipment layaway tend to reduce the quantity of qualified individuals that can be found. Under those

c. Provision for control backup and startup

B. RECOMMENDATIONS

1. Communications between AAP facilities with similar technologies should be encouraged and expanded to include technical discussions on equipment standardization, common layaway and startup problems, skill retention programs, etc.

2. Design the automation/mechanization equipment for each operation or process at the lowest possible level of complexity, using the most simple and least sophisticated control system. This criterion has not been utilized in the production lines surveyed by the study team.

3. Where available, compile past startup time records of LAP and P&E lines plant production lines to learn the effects on startup time and costs of layaway, maintenance, and startup planning practices. This type of information is invaluable in assessing problem areas and providing selective solutions.

4. Intraplant and interplant standardization of processes and equipment should be the first order in developing and procuring production machinery. This would facilitate pooling of skills, documentation, perishable tooling, and spare parts inventory. Many contractors are reluctant to record <u>all</u> operational data because they consider at least some of it to be proprietary. This practice is not in the Government's best interest because it can impede standardization and skill retention programs.

5. Design production lines with a capability to operate at a partial as well as a maximum rate. Recently installed systems designed to operate at full mobilization rate do not reflect the necessity of a much lesser production requirement for peacetime field training and defense stockpiling. Further, efficiencies generally suffer and procurement and operating costs rise when attempts are made to develop equipment with extreme ranges of production output.

   Army ammunition plants' unique production requirements plus the necessity of periods of indeterminate idleness suggest the consideration of alternate design philosophy. Modern machine control flexibility can provide central control to any number of production systems, and by installing several parallel lines which can be operated from a single line through succeeding lines flexible production

circumstances experienced manpower should be used for on the job training of inexperienced personnel.

In addition to manual skill retention, planners of production systems should take advantage of the many teaching methods that can be effective in providing a form of skill retention. Special format manuals, slide transparencies, movies and animated cartoons, discs and tape cassettes for closed T. V. presentations, etc., are some of the ways that could be used for storing and disseminating information. Programs of instruction can be maintained at the plantsite or distributed to the plant from another location. Several plants, widely dispersed, could receive T. V. instructions simultaneously.

Carefully prepared lessons tailored to meet specific needs can expedite the indoctrination of any intelligence level into any subject within the scope of that intelligence. Private industry, schools, government agencies, advertising and sales programs have all successfully applied modern instruction techniques. Skill retention problems can be materially reduced through use of properly prepared teaching programs disseminated through "canned classrooms".

Moreover, current control technology strongly indicates that skill retention is more than labor utilization. Skills can be retained through the application of solid-state technology. Control modules programmed to direct a series of sequential operations can be plugged into the equipment. Detailed instructions for application of the "black box" can be etched into a visible surface of the module. When layaway is required, the module can be unplugged and carefully stored. Activation of the module may occur through manual means, another module, computer, microprocessor, etc.

9. Assure that follow-on maintenance and startup procedures are engineered for a particular production line concurrently with the layaway procedures. Machines and process lines are often modified to suit production requirements. Any changes must be fully documented and included with standard startup procedures.

10. Engineering design of control systems must include data on control life expectancy. Further, mechanized systems must have provisions for override of automatic controls that will permit manual operation and manual startup.

11. Conduct an actual startup exercise. Although each of the plant operators have signed statements to the effect that startup of their lines currently in a layaway condition can be reactivated within the specified mobilization time period, they admit privately that it would be difficult or impossible to satisfy that condition. This can be traceable to a number of things, including lack of direction concerning layaway, absence or incomplete compiling of the necessary documentation for both layaway and startup instruction, lack of spare parts, lack of necessary skills, and especially lack of the necessary funding to accomplish these items. We suggest as both a check and operational exercise to conduct an actual startup time for an automated/mechanized line is to take a production system out of layaway and operate it to a specified line production rate.

    The operation selected for the purpose should include a multiplicity of machine types, a variety of control systems, an end product that is manufactured from several components, and a mix of manual and automatic duty functions. To further implement and make the startup exercise more meaningful, the production line or lines should be in more than one building and occupy a large area. Under peacetime conditions, any startup endeavor conducted to such a large magnitude could require months of planning, but this is to be a mode simulation and the only preparation necessary is the Army's selection of the facility and production line to be activated and selection and briefing of the contractor.

    There are several ways to perform the task as follows:

    a. The AAP is inactive. A contractor other than one in the munitions manufacturing sector, is selected. The contractor is one familiar with production line operations and has completed many "turnkey" contract.

    b. The AAP is inactive. If a contractor is still responsible for the facility, he is awarded a contract to start up the selection system.

    c. The AAP is inactive. A contractor operating an active AAP is awarded the startup contract.

    d. The AAP is partially active, with many operations in layaway. An outside contractor is selected for the task.

e. The AAP is partially active, with many operations in layaway. The operating contractor conducts the startup.

f. The AAP is partially active, with many operations in layaway. An operating AAP contractor other than the one operating the facility is selected.

APPENDIX

APPENDIX A

APPENDIX A

GLOSSARY

MANUAL OPERATION

Any function of mechanical apparatus or process system that must be actuated or manipulated through human effort.

MECHANIZATION

Any function of mechanical apparatus or process system that is conducted by means other than manual effort but still requires human observation, action, and decision to activate and monitor the operation.

Mechanized systems permit machine operations that are often beyond the manipulative skill or physical reaction capabilities of the human operator. Repetitive tasks can be performed faster, more efficiently and accurately, thereby reducing manual labor requirements and ensuring a better, more consistent quality product. In addition, manual remote control of isolated machinery is easily effected. Moreover, mechanization provides capabilities that allow coordination of machines, material handling elements and inspection devices into an integrated system.

As used in this report, it includes the concept of automation.

AUTOMATION

When surge capabilities are designed into a mechanized system, feedback control will provide a closed loop system that can actuate, monitor, and direct machine function, tool condition, and product flow. When necessary, corrective action is taken to prevent or correct machine malfunction or process error. Ideally, an automation system will not require human physical effort or control decisions.

DOCUMENTATION

Documentation is a technical data package consisting of packing lists, inspection and test reports, operating and installation instruction, historical records and diagrams of electrical and hydraulic systems and utility connections. When specified, the documentation shall include photographs, manufacturing procedures and other required technical data. (This is not the same as "total document package")

EXERCISING OR CYCLING

Periodic operation of a machine under no-load conditions through all cycles.

LAYAWAY

Retention of industrial production facilities and supporting utility service lines, special tooling and special test equipment not required to support current production but which are required for items identified for production for general force level as necessary to meet an established activation schedule.

MANUAL OPERATIONS

Action performed by hand and not mechanized or automated by machine or process control.

MECHANIZATION

The act or process of using power-driven machinery to perform specific operations or functions usually with the intent of improving productivity and/or quality of the work performed. As used in this report, it also includes the concept of automation.

MODERNIZATION

A term denoting the improvement of industrial facilities to reflect technological advances by process and equipment upgrading, replacement, or additives. Advantages include increased productivity and quality, reduced costs, and safety improvements.

OLEUM

100% sulfuric acid plus absorbed SO_3.

PRESERVATION

Application or use of adequate protective measures to prevent deterioration resulting from exposure to atmospheric conditions, fungus, excessive drying, high humidity, fumes and gases when being handled, stored or shipped.

SKILL RETENTION

Refers to the retention of operational know-how of production facilities. The know-how can be in the form of experienced personnel and/or complete documentation (also termed "total documentation"), including training programs for operators, maintenance personnel, and engineers.

STARTUP

The preparation for activation of a laid-away facility.

STORAGE

Government-owned facilities placed in a layaway status when they are no longer required for current production, but are required to provide a mobilization capability not attainable from private industry.

TOTAL DOCUMENTATION PACKAGE

A program concept funded at the time of equipment procurement that expands the Technical Data Package includes layaway and follow-on maintenance procedures, engineering specifications current to time of layaway and stored at the layaway site, specific directions, if necessary, relating to special machinery or facilities design, training courses for all personnel associated with the operation, detailed instructions for startup and a supply of end products to facilitate machine set up and operation.

APPENDIX B

APPENDIX B

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APPENDIX C

APPENDIX C

KAISER ENGINEERS

PLANT EQUIPMENT PACKAGE (PEP)
MODERNIZATION PROGRAM

file

TRIP REPORT

CONTRACT NO. DAAA21-75-C-0303

KE JOB NO. 75086 - 006

PREPARED BY: R. K. Reynolds

DATE: November 2, 1976

APPROVED BY: [signature]

PLACE:	CONTACT:	DATE:
LONE STAR AAP Texarkana, Texas	Joe B. Alexander Chief, Engrg. Div./COR (214) 838-1305	19 to 22 Oct. 1976

PURPOSE:

Determine the relationship of machine controls and complexity on startup time by evaluating a modernized production line

PARTICIPANTS:

See Below

DISTRIBUTION:

H. W. Flippen
J. S. Ritchie
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D. J. Pearse
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SAI File
PBM-G

REPORT

KE/SAI

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LS AAP - COR

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Madison Bagley, Engrg. Div./COR
Larry A. Henry, Engrg. Div./COR

LS AAP-D & Z

Billy G. Sams, Chief, Plant Support & Project Mgmt. Dept. Day & Zimmerman
Loyd Harper, Engr. Dept., D & Z
Carlton Fountain, Engr. Dept, D & Z (formerly a line supt.)

1. INTRODUCTION

In accordance with the Deputy Project Manager's direction, Kaiser Engineers in association with Stetter Associates, has initiated a study of AAP equipment/lines to access the impact of automation and mechanization levels on start-up time.

Four AAP's representative of the P & E, LAP and metal parts production categories were selected as follows:

LONE STAR AAP
RADFORD AAP
IOWA AAP
SCRANTON AAP

2. SUMMARY

The Lone Star AAP was visited to determine the current status of production lines (operating or in layaway) and one line was selected for more detailed study. The line selection and subsequent data collection was a mutual effort between AAP personnel and the study team.

Government and contractor-operator personnel were interviewed. Seven production lines were surveyed and one line was then selected as the most representative of highly mechanized equipment and associated controls and evaluated in more detail. Pertinent data were collected. for further evaluation.

3. BACKGROUND INFORMATION, LSAAP

a. Primary mission of the plant is to load, assemble, and pack artillery and component items. The Contractor-operator is Day & Zimmerman and the plant is located near Texarkana, Texas.

b. The personnel level is currently at 1200 (85 of which are government employees), compared to 12,000 during the Vietnam war.

4. INTERVIEWS

a. Comments by government personnel are summarized as follows:

(1) Layaway procedures are inadequate.

(2) There are no written start-up procedures for the production lines in layaway.

(3) The mobilization targets are only estimates of the contractor-operators. Actual start-up, particularly of modernized lines, would be required to accurately determine any start-up problems and their extent.

(4) Their policy now is to update production lines from a cost-effective standpoint, not just 100% "modernization" (mechanization).

(5) Government engineers were not assigned to Army GOCO ammunition plants until 1971.

b. Comments by D & Z personnel are summarized as follows:

(1) Layaway procedures are inadequate; particularly for lines with complex equipment. In addition, the guidelines are continually changing.

(2) Unless planned for in advance, spares are not set aside for layaway lines.

(3) Periodic cycling of modernized lines in layaway should increase component life and reduce start-up time.

5. EVALUATION OF PRODUCTION LINES

a. Table I (this report) summarizes the cursory examination of the production lines that were recommended by COR and D & Z engineers. Carlton Fountain was our guide for all lines except the M567 fuze. Madison Baglet was our guide for that line.

b. After an evaluation of the preliminary data gathered, the study team chose the M557 fuze line for further study.

6. M557 FUSE LINE EVALUATION

a. The design capacity of this line was 12,000 units per an 8-hour shift. Record output achieved during its 3 years of operation exceed 16,000 units/shift.

b. An IBM sketch shows a minimum of 22 operators were required. The final layout (D & Z Drawing E-8010-14) indicates that at least 30 operators were needed . . . many manual operations.

TABLE I

SUMMARY OF LINE EVALUATION

LONE STAR AAP

End Item(s)	Production Line: Bldg	Production Line: Status	Comments
M557 Fuze	M-5	Layaway Since Nov. 1975	• First modernized line at LSAAP, and first modernized fuze assy line in AAP complex.
		Operational From 1970 to Dec. 1973	• "Floating pallet", in-line processing. • Designed & built by IBM, debugged by D & Z • Most complex line (both mechanically & control-wise) observed at LSAAP.
M567 Fuze	K-14	Debugging starts in Jan. Future unknown	• 13 Honeywell rotary dial assembly machines, w/manual transfer between machines of intermediate assys in magazines. • Up to 24 stations per machine; std. M-H programmable controls
M28B2 Primer	R-38	Inoperative last 8 mos.	• Second line that was modernized at LSAAP. • Numatic controls, Car-Trac conveyor system; mechanical complexity only moderate
105 mm LAP	E-15 E-17	Inoperative Since '73	• Melt-pour modernization complete by '78. • In-line processing; floating fixtures, cable drawn; primarily electrical control. • Moderate mechanical complexity
Detonators (delay type)	P-27	Inactive; Never put into prod.	• Trans-O-Matic loading machine with 19 stations; manual handling of explosive
Detonators, Primers, etc	Q-28	Operational	• WW-II vintage Jones rotary loaders.
	Q-29		• Wheaton rotary loaders; many manual operations
	R-8	Operational for a month Still debugging	• Mixture of modern machines (such as the Swanson loader for the M82 primer) and many manual operations (e.g., the 1914 vintage black-powder loader for the M86 primer).

c. Total number of basic stations exceeds 70. Forty-eight of these are automatic with manual override.

d. Air controls and actuators (totaling approximately 5,000 in number for the complete line) were used extensively. It was obvious that the designers used electrical systems only when necessary (e. g., Syntron feeders). The only hydraulics seen were part of 4 presses at the end of the line.

e. The air logic control components, furnished primarily by Numatics, require clean, dry, non-lubricated air. Final filters are located in the "Hoffman" enclosure boxes. The actuators and power valves were supplied with standard shop air.

f. Extent of layaway measures:

(1) Machines surfaces had been cleaned and a light preservative oil applied.

(2) Air condensate had been drained and a few of the air lines were disconnected.

(3) An automatic dehumidifier maintained the relative humidity near 35% MOST of the time. Hydrothermagraphs at the machine showed that the R. H. reached 60% last April.

(4) Informal and incomplete maintenance record books were stored at most of the stations. Rolls of drawings were also found at certain stations. The tool room record appeared complete.

7. DATA RECEIVED

a. Assembly (8863535) and sub-assembly (15 sheets) drawings of M557 fuze.

b. Technical Manual, "Preparation of Industrial Plant Equipment for Storage or Shipment", TM 38-260, etc. June 1975; 124 pp.

c. SOP-384, "Standing Operating Procedure for Floating Fixture System for Assembly of M557 Fuze"; 126 pp.

d. D & Z Drawing #E-8010-14, "General Equipment Layout Area M" (M557 fuze line); and SK-1854-1, "IBM Floating Fixture System, M557 Fuze".

e. D & Z Drawing #E-9392, Sheet 1, "Installation of Equipment F/M 567 Fuze Auto. Assy"; and Parts Flow Diagram drawing(no number).

f. Letter, DRSAR-PPI, 22 September '76, Subject: Definition and Policy - Layaway During Austere Funding Periods (ARCOM Production Base), with one enclosure (8 pp).

g. Three letters, D & Z to COR, dated 5 Nov. 75, 12 Mar. 75 and 30 Mar 76, Subject: Engineering and Maintenance Procedure No. 34 and Cycling of M-Line Automated Equipment, W/I enclosure (Procedure 34, 3 pp).

KAISER ENGINEERS

file

PLANT EQUIPMENT PACKAGE (PEP) MODERNIZATION PROGRAM

TRIP REPORT

CONTRACT NO. DAAA21-75-C-0303

PREPARED BY: R.K. Reynolds

KE JOB NO. 75086 - 006

DATE: 20 December 1976

APPROVED BY: [signature]

PLACE:
Iowa AAP
Burlington, Iowa

CONTACT:
Jos. C. Lestage, Division Engineer, 319/754-5731

DATE:
16-18 November 1976

PURPOSE:

Determine the relationship of machine controls and complexity on startup time by evaluating a modernized production line.

DISTRIBUTION:

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Leland Hobson, Maintenance Technician

REPORT

Introduction

In accordance with the Deputy Project Manager's direction, Kaiser Engineers in association with Stetter Associates, initiated a study of AAP equipment/lines to assess the impact of automation and mechanization levels on start-up time.

Five AAPs representative of the P&E, LAP and metal parts production categories were selected as follows:

Lone Star AAP
Scranton AAP
Radford AAP
Iowa AAP
Volunteer AAP

Summary

The Iowa AAP was visited to determine the current status of production lines (operating or in layaway), and two lines were selected for more detailed study. The line selection and subsequent data collection was a mutual effort between AAP personnel and the study team.

Government and contractor-operator personnel were interviewed. Seven production lines were surveyed and two lines were then selected as the most representative of highly mechanized equipment and associated controls and evaluated in more detail. Pertinent data were collected for further evaluation.

Background Information, Iowa AAP

a. Primary mission of the plant is to load, assemble, and pack artillery and component items. The contractor-operator is Mason & Hanger-Silas Mason Company and the plant is located near Burlington, Iowa.

b. The personnel level is currently at 1400, compared to 8000 during the Vietnam war.

Interviews

a. Comments by government personnel were perfunctory.

b. Comments by contractor personnel are summarized as follows:

(1) Factors which are likely to adversely affect startup are:

- The lack of retention of skills, including the effect of union seniority rules on retention of younger and more technically qualified personnel.

- The requirements to simultaneously startup several lines with a limited staff.

(2) Major machine manufacturers (e.g., Cross, Sundstrand, Barnes) are no longer inclined to bid on government orders, due to "red tape" and contractual restrictions. Consequently, only small and usually less experienced machine manufacturers are willing to bid and build special machines.

(3) Personal inspection at certain stages of manufacture is required by specifications. For particular stages, the contractor considers the requirement superfluous or redundant.

(4) Their own staff disagrees on the degree of automation/mechanization that is desirable, since a certain amount of flexibility is usually sacrificed.

(5) Their experience with universal type transfer machines (specifically, Unimates) was negative, due to excessive maintenance and out-of-spec. performance. (Note: machines were misapplied by being used as single-purpose transfer machines.)

(6) Their policy is to procure new machines on a "turnkey" basis from the low bidder, without their own review of the machine's engineering features. The reason given for this policy was was that purchaser review would compromise supplier responsibility. (Since the purchaser must operate and maintain the machine, and since engineering drawings often do not reflect what the specification writer intended, their relinquishment of engineering review appears questionable.)

(7) Layaway:

- Most IAAP equipment laid away "in-place".
- Maintenance of same is dependent upon the funding for that year.
- They prefer to disassemble machines to the degree that exercising, heat, humidity control, etc., is not required.
- Water and oil in the compressed-air lines is a major problem.
- Iowa AAP has 37 warehouses full of PEP equipment.
- Drum memory of the warhead line controls will require a controlled environment. Cassette or floppy disc would be preferred for future memory units.
- They prefer to cutoff all services to an idle building, in order to reduce hazards.
- Component obsolescence becomes a major problem after extended layaway.
- Hydraulic pumps are expected to require rebuilding after layaway.
- Leaving gear cases inactive and filled to their normal operating level (less than half full) produces corrosion at the oil level line, where atmospheric moisture condenses.

(8) Startup estimates

- Three (3) weeks or 360 manhours for <u>one</u> Iowa detonator loader. Approximately the same time required for layaway (excluding decontamination).
- 30 days for the 155mm drill line (3A-05-2); another estimate was one <u>week</u> to reach full production.

(9) Their working policies or industrial practices are strongly influenced by recommendations of the Army and GAO (Industrial Management Review division), and by the type of production contract. The contract is a cost plus award fee, with the fee dependent upon the degree of contractor compliance with government regulations.

(10) A six-man team performs a cursory inspection of inactive lines once a month.

(11) One of their design principles that reduces the hazard factor in equipment is the use of fail-safe and redundant components.

5. Evaluation of Production Lines

Table I (following page) summarizes the cursory examination of the production lines that were recommended by Mason & Hanger personnel. Our guide was Mr. Jos. C. Lestage, Division Engineer. The table also summarizes the preliminary data evaluation. Two lines were chosen for further study: the Warhead Load Line because of the relative complexitiy of its controls; and the Iowa Detonator Loader Line because of its mechanical complexity.

6. Evaluation of Warhead Load Line

a. The Warhead Loading Facility consists of a single melt unit, a pouring unit, and three solidification bays for the production of shaped charge warheads for the TOW, Dragon, and Hawk projectiles. Controls for the melt and pour operations are local, located adjacent to each piece of equipment. Controls for all three solidification or conditioning bays are located in a separate control room. Each conditioning bay (Photograph 2) has 16 fixture carts (Photograph 1), and each cart has 5 molds. Thus one cycle would produce (3) (16) (5) = 240 warheads, which is also the rated output/shift of the facility.

b. The process includes preheating the warhead metal parts, filling the metal parts with molten explosive, and automatically controlling the solidification cycle of the explosive. The latter is the most important, since it improves the uniformity of the cast explosive.

c. Octol, a mixture of TNT and HMX, is melted in a stationary Groen vacuum kettle of 2,000 # capacity. The kettle uses steam and hot water for temperature control, and an agitator to assure mixing of the Octol. The kettle is monitored and controlled from the adjacent control panel, Photograph 3. When the explosive is ready for pouring, it is released through a bottom valve to the automatic pouring machine in the bay below (photograph 4).

d. The automatic pouring machine controls by pneumatic logic the level of explosive in its reservoir and in each funnel of a cart. A pour cycle, which takes only 45 seconds, can be controlled either automatically or manually.

e. The basic solidification cycle (approximately 6 hours long) consists of (a) vibrating the warheads (to release entrapped air) during the first 20 minutes; and (b) varying the temperature control of the warheads and of the risers so that sound, directional solidification is achieved.

f. The control room for the conditioning bays includes a process control computer (Data General Nova 1210), a teletype, and a control console with a separate control panel for each bay. (Photographs 5 & 6).

SUMMARY OF LINE EVALUATION

TABLE I

	Description	Location	History	Control Mode	Degree of Complexity Mech.	Degree of Complexity Controls	Comments
1	Warhead Loading (melt, pour & cool warheads for TOW, Dragon & Hawk)	1-05-2	Operational 2 years.	Computer (f) = process sequencing & data logging, but no corrective action. Some air control. Manual override & set points.	2	8	a) Improvement of product quality is major benefit. Manual line unsatisfactory. b) Production capability increased from 90 to 225 warheads/shift, using same manpower. c) Overall product cost substantially reduced. d) Only 4 hours of downtime in last $1\frac{1}{2}$ years of operation. e) Machine & controls designed by M&H.
2	Iowa Loader, Detonators (M17, M24, M55, M61)	6-34-2	a) One machine operational for M2A2 b) 10 machines, Mod.1, operated 6 yrs., decon. in '75, L.A.	Primarily mech., plus elec. & air fluidics.	8	4	• Rotary index type of machine which has evolved from the WW II vintage Jones Loader. 24 Stations available. • Production rate is 40 to 44 detonators/minute. • Layaway & startup experience good. Rated good in reliability.
3	Assembly of 155mm (M107)	3A-12	Shut down June '76 during debugging period.	Pneumatic & Allen-Bradley Cardloc	7	5	• Design rate of production is 8/min. • This mechanized line will require 13 operators (vs.24 for the manual line). • Line includes automatic X-ray system, weighing, and supplementary charge insertion.
4	155mm Drill System	3A-05-2	IA June '76, after processing 1 mill. parts.	A/B Cardloc	5	5	• Line includes remote 8-spindle drilling, thread brushing, automatic inspection, and expanding collet type of unloader.
5	Autom Powder Weigh & Primer Insert (90mm)	2-13	LA 1974; expect reactivation soon.	Elec.-mech.	5	6	Except for one Unimate, line's equipment relatively conventional.

LA = layaway
IA = inactive
OP = operational

	Description	Location	History	Control Mode	Degree of Complexity		Comments
					Mech.	Controls	
6	M61 Percussion Primer Machine	6-34-3	Dry debugged; never in prod. Now LA.	Air-elec. - mech.	8	3	• Design capacity is 250 parts/min. Six operators required. • Design and machine respected by M & H engineers.
7	155mm Depalletizing	3A-04	OP since '74	Elect.-hyd. -pneumatic	6	7	• Production rate is 2500 shells/shift, which is twice that of adjacent manual line. • Metal banding broken and pallet cover removed, then two Unimates remove plugs and transfer shells into fixtured car.

LA = Layaway
IA = Inactive
OP = Operational

Each panel can be operated either automatically by the computer or manually by the operator.

g. In the automatic mode, all errors or abnormal conditions are recorded on the teletype. The control room operator then determines and takes the required action to correct the errors.

h. An intercom system connects the control room to each solidification bay, the kettle bay, and the automatic pouring machine.

7. Evaluation of Iowa Detonator Loader

a. The current series of loaders, Model 1, were built to M&H design specifications by the Doerfer Corporation of Waterloo. Estimated cost today in quantities of three is $90,000 each.

b. A later version, Model 2, is being designed. It will require fewer operators and have the same production rate (40 detonators/minute). Another design version (designated Model X-4) with quad-tooling that produces 150 detonators/minute has been proposed for development.

c. Line superintendents estimated that layaway of a loader requires a total of approximately 360 manhours (2 millwrights, plus part-time electrician and pipefitter). After a 3-year layaway with interim maintenance, the same number of manhours (360) would restore the machine to operating condition, but the operator training period would extend the startup time to three months.

8. Data Received

(a) Organization charts (2).
(b) Mason & Hanger's response to General Nord's inquiry regarding retention of skills; dated 29 October 1976.
(c) "Master Layaway Plan, Iowa AAP", dated 1 February 1972, 69 pp.
(d) "Decontamination, Layaway, and Maintenance of Facilities", dated 1 October 1971, 144 pp.
(e) Data and photographs (8) of Iowa's M61 Percussion Primer Assembly Machine.
(f) Photographs (4) of the warhead melt-pour line (1-05-2).
(g) Machine Tooling Layout, Iowa Detonator Loader (M55 detonator); drawing number 6G-T616.
(h) "Computerized Processing of Warheads", by Lichtenberger of Mason & Hanger; presented at ADPA 1976 meeting; 20 pp.

KAISER ENGINEERS

PLANT EQUIPMENT PACKAGE (PEP) MODERNIZATION PROGRAM

TRIP REPORT

CONTRACT NO. DAAA21-75-C-0303

KE JOB NO. 75086 - 006

PREPARED BY: R. K. Reynolds

DATE: 15 December 1976 (Rev. 24 January 1977)

APPROVED BY:

PLACE:
Radford AAP
Radford, Virginia

CONTACT:
Jos. G. Smythers, Chf.
Operations Review Div.
(703) 639-8649

DATE:
3-4 November 1976

PURPOSE:

To determine the relationship of machine controls and complexity on start-up time by evaluating a modernized production line.

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Asa E. Roane, Engineer, Modernization Section

REPORT

1. INTRODUCTION

In accordance with the Deputy Project Manager's direction, Kaiser Engineers in association with Stetter Associates, has initiated a study of AAP equipment/lines to assess the impact of automation and mechanization levels on start-up time.

Five AAP's representative of the P&E, LAP and metal parts production categories were selected as follows:

Lone Star AAP
Scranton AAP
Radford AAP
Iowa AAP
Volunteer AAP

2. SUMMARY

The Radford AAP was visited to determine the current status of production lines (operating or in layaway) and one line was selected for more detailed study. The line selection and subsequent data collection was a mutual effort between AAP personnel and the study team.

Government and contractor-operator personnel were interviewed. Six production lines were surveyed and one line was then selected as the most representative of highly-mechanized equipment and associated controls and evaluated in more detail. Pertinent data were collected for further evaluation.

3. BACKGROUND INFORMATION, RADFORD AAP

a. The contractor-operator is Hercules, Inc., and the plant is located in Radford, VA.

b. The mission of the plant is to manufacture propellants and explosives.

c. The current level of contractor manpower is 2400, compared to a high of 9,500 in the Vietnam era.

4. INTERVIEWS

a. Comments by government personnel are summarized as follows:

1) The contractor's engineering department (approximately 100 people) has substantial talent and experience, aided partly by development contracts from Picatinny.

2) Due to a lack of funded programs, little engineering has been done on layaway or start-up procedures.

b. Comments by Hercules personnel are summarized as follows:

1) They are very concerned with the problem of skill retention, as shown by their 12-page response to General Nord's inquiry.

2) Periodic cycling of acid plants creates excessive maintenance.

3) Their engineers anticipate and recommend use of microprocessors for new equipment.

5. EVALUATION OF PRODUCTION LINES

a. Table I (this report) summarizes the cursory examination of the production lines that were recommended by COR and Hercules personnel. Guides were Jablonski, Andersen and Roane.

b. After evaluating the preliminary data, the study team chose the Automated Continuous Single-Base Line for further study.

6. EVALUATION OF AUTOMATED CONTINUOUS SINGLE-BASE LINE

a. This line is designed and being built with a design capacity of 1250 tons per month of M6, M1SP, or M1MP propellants.

b. Personnel will be reduced from 364 for the manual batch line to 96 for the automated continuous line.

c. From the input to the manufacturing building to the loadout from the finishing building, there are two parallel lines. There is no surge capacity in the system.

d. TV cameras are located in several key areas. The contractor expects to have technicians roving continuously throughout the production areas.

e. Samples will be manually extracted and carried to a nearby test lab.

f. Total investment is forecast at $56 million, including a $6-million estimate for debugging (Prove-out and Acceptance).

g. Apparently, manufacturing cost reduction is questionable, due to recent increases in power costs.

h. Controls

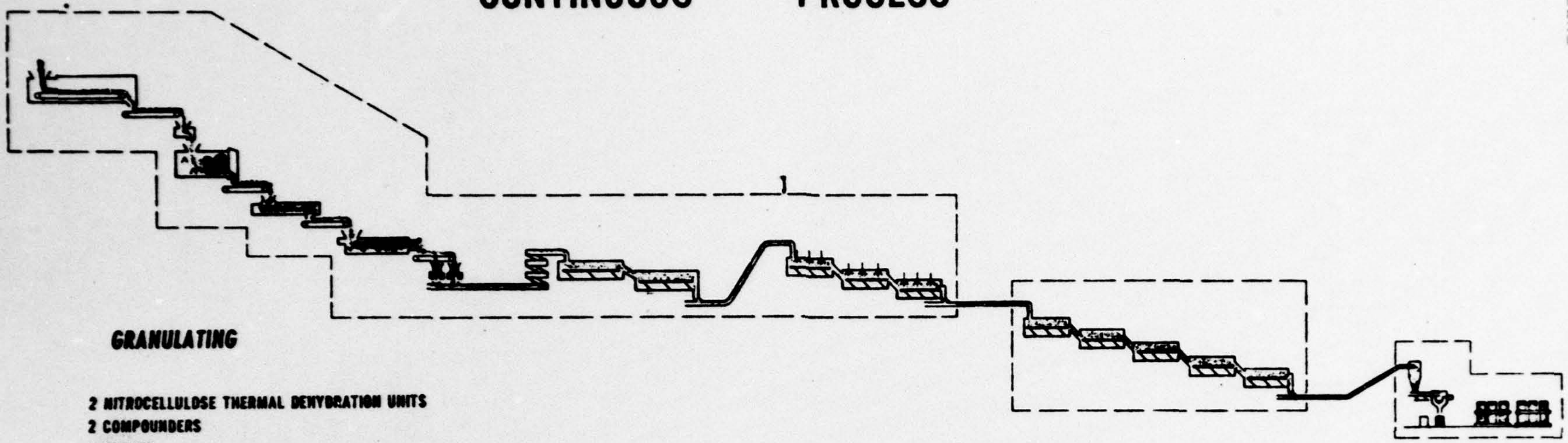
Physically, the process has been separated into three distinct operational buildings (granulating, drying and packaging), plus a separate and isolated control building. The process is remotely controlled utilizing a PCP-88 computer, consisting of two Digital Equipment Corporation PDP-8/1 mini computers and peripheral equipment.

TABLE I

SUMMARY OF LINE EVALUATION

END PRODUCT	PRODUCTION LINE		COMMENTS
	DESIGNATION	STATUS	
Weak Nitric acid (61% HNO_3)	Ammonia Oxidation Process (AOP)	Inoperative; built '72; shut down '74	Reportedly a conventional and proven design, except for environmental control innovation (not completely successful).
98% HNO_3 + 67% to 93% H_2SO_4 byproduct (Input is weak nitric acid)	Nitric Acid Concentrator (NAC/SAC), #1	Operational since 1974	• Controls conventional for process industry • Except for controls, all equipment open to atmosphere • Very high maintenance; "self-destructive" type of plant. • Plant never shut down unless required for maintenance
	(NAC/SAC) #2 & #3	Unfinished; 95% complete	• Equipment in a building • Reportedly a better design than #1 line
Oleum (100% H_2SO_4 + absorbed SO_3)	Sulfuric Acid Regeneration (SAR)	Built 1972. Now inoperative except for periodic cycling (every 3 months)	• Input is the dilute H_2SO_4 byproduct from NAC/SAC line. • Line capacity greatly exceed current needs, hence the periodic operation--which creates excessive maintenance (e.g., furnace refractory lining).
Nitrocellulose (NC); high or low grade	Improved Nitrocellulose (IN)	Operational	• This proprietary continuous process replaced a batch line. • Controls are analog plus remote manual.
Single-Base Propellant	Continuous Automated Single-Base Line (CASBL)	Scheduled start of "Prove-Out and Acceptance is Feb. 1978	• Controls: direct digital controller (DDC) plus limited local backup control (manual) • Compared to the WW-II vintage batch process that it will replace, this line requires only 25% as many personnel.

CONTINUOUS PROCESS



GRANULATING

2 NITROCELLULOSE THERMAL DEHYDRATION UNITS
2 COMPOUNDERS
4 MIXERS
4 EXTRUDER
CUTTER ASSEMBLIES
8 SOLVENT REMOVAL ASSEMBLIES

IN THIS BUILDING, WATER WET NITROCELLULOSE IS DRIED, COMPOUNDED WITH SOLVENTS, THOROUGHLY MIXED, AND EXTRUDED INTO STRANDS, WHICH ARE CUT INTO GRANULES. PROCESS SOLVENTS ARE THEN REMOVED FROM THE GRANULES.

*Horizontal extruders and small vertical extruders have been eliminated. In place, vertical screw extruders with shuttle cutters will be used.

**The spiral elevator conveyor has been replaced with a hydraulic conveying system.

***The solvent removal assembly now consist of nine modules.

DRYING

5 DRYER UNITS

IN THIS BUILDING, THE WATER WET GRANULES ARE DRIED AS THEY PASS THROUGH HEATED AIR.

PACKING

1 CAN PACKING UNIT
1 PALLETIZER UNIT
1 TRANSFER CAR
1 STAGING CONVEYOR

IN THIS BUILDING, THE GRANULES ARE PACKAGED IN CONTAINERS, WHICH ARE THEN PALLETIZED, STAGED IN TRUCK LOAD LOTS, AND AUTOMATICALLY LOADED INTO TRUCKS FOR SHIPMENT.

The operational mode is direct digital control (DDC). One computer functions as the Control Processor (CP) and performs the DDC operations, sequential control communication functions and system security monitoring.

The second computer functions as the Supervisory Processor (SP) and receives the same information fed to the process controller, but it is normally used for off-line functions such as data logging, supervisory control and plant engineering functions. In the event of a failure of the CP, the SP assumes the control functions. The system has over 300 analog input sensors and nearly 100 DDC loops. Final control devices are principally motors (electric and pneumatic) and valves. The computer software is still in the process of development and debugging. Although industrial-type process controllers exist (mounted on free-standing panels) for performing the function of manual set point control, funding constraints permitted their inclusion as on-line backup for only a limited number of process control loops.

7. DATA RECEIVED:

a. Organization charts

b. Hercules' response to General Nord's inquiry regarding retention of skills; dated 26 October 1976

c. Booklet titled "Continuous Automated Cannon Propellant Facility"; 16 pp.

d. Process flow sheet for the automated single-base line.

e. "Automated Single-Base Line Facility Site and Process Description"; 91 pp.

RKR/dsl

KAISER ENGINEERS

PLANT EQUIPMENT PACKAGE (PEP) MODERNIZATION PROGRAM

TRIP REPORT

CONTRACT NO. DAAA21-75-C-0303

KE JOB NO. 75086 - 006

PREPARED BY: R. K. Reynolds

DATE: January 12, 1977

APPROVED BY:

PLACE:
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Chattanooga, Tenn.

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DATE:
30 Nov.-1 Dec. 1976

PURPOSE:

To determine the relationship of machine controls and complexity on start-up time by evaluating a modernized production line.

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REPORT

1. INTRODUCTION

In accordance with the Deputy Project Manager's direction, Kaiser Engineers, in association with Stetter Associates, initiated a study of AAP equipment/lines to assess the impact of automation and mechanization levels on start-up time.

Five AAP's representative of the P&E, LAP and metal parts production categories were selected as follows:

Lone Star AAP
Scranton AAP
Radford AAP
Iowa AAP
Volunteer AAP

2. SUMMARY

The Volunteer AAP was visited to determine and assess the current status of TNT production lines and equipment, both operating and inactive. The only operational line (#1 continuous) was evaluated in detail from a standpoint of the application of mechanization and controls.

3. BACKGROUND INFORMATION

Time Period		Event
From	To	
WW-II	1946	16 manual batch lines built and operated
1946	Nov. 1952	Layaway, with good interim maintenance
June 1953	1957	Operating
1958	Sept. 1965	Inactive; no interim maintenance (e.g., entire budget of $350,000 in 1960 used for security and fire protection)
Mar. 1966	Feb. 1975	Six months (and $28 million of reactivation funds) to initiate manual batch line production, then an additional line activated each month, until 10 lines were operational.
1974	Present	Six continuous CIL* lines built, one operational

*Canadian Industries, Ltd (Developed continuous TNT process).

4. OPINIONS (Government and Contractor Personnel)

A. Reactivation Sequence: All agreed that either continuous line 2 or 3 would be chosen for initial start-up, since those lines would provide the best operator training.

B. Reactivation Training: All agreed that there is not now sufficient recorded information to transmit present know-how to new and inexperienced personnel. Also, it would take 10 to 12 weeks to train additional personnel on the assumption that a nucleous of personnel existed having prior operating experience. The number of experienced personnel available to form this nucleus in the future will be drastically reduced, due to the decreased number of personnel required per line.

C. Reactivation or Start-up Time Estimates: All agreed that start-up of one of the continuous CIL lines would require approximately three months, plus an additional six weeks to achieve in-specification production. Start-up of one of the old manual batch lines would require six months, due to their poor condition. These estimates assumed:

1) Availability of a nucleus of experienced personnel
2) All pending modifications completed prior to layaway
3) Proper layaway
4) Maintenance during layaway. Note that multiple, unrepaired failures in the digital controls become increasingly difficult

to correct, since the computer is used in diagnosing its own failures.

5) Availability of spare parts at time of start-up. (This assumption appears unrealistic, particularly with respect to the digital controls, which are already obsolete and not being produced.)

D. Hindsight: If modernization of the TNT manual batch lines were to be done again, the contractor's engineers would prefer to replace them with remotely-operated batch lines, using stainless steel, analog-type controls, and permanent buildings.

E. AOP and Acid Plants: There are no plans to add computer controls to these lines. Also, the single oleum plant with a capacity of 580 tons/day lacks the flexibility for reduced production, and must be shut down approximately three months out of four.

F. It may be possible to increase the TNT yield from a given quantity of raw materials by optimizing the variables (e.g., concentrations, temperatures, flow rates).

G. Visual observation of color changes of the in-process material assists in maintaining quality. Additional instrumentation could replace this method.

H. Modernized batch lines should be somewhat simpler to lay away than modernized continuous lines.

I. Several studies have been made of layaway means for computer controls. Cycling annually or at a more frequent rate is recommended.

J. Equipment drawings are not always kept up to date.

K. The software developed for the present controls (Foxboro PCP88) should be applicable to newer controls.

L. Volunteer personnel suggested that the problem of rapid obsolescence of the direct digital controls could be alleviated by periodically replacing the controls (e.g., every three years) with the latest state-of-the-art controls. They pointed out that the total cost of the six CIL continuous production lines was $42 million. The controls cost was $2.3 million and since that time, the cost of controls and the amount of wiring required has decreased substantially. More on this important subject will be covered in the final report.

5. EVALUATION OF CONTINUOUS CIL LINES

Six production lines have been built, using almost identical stainless steel equipment but with different controls, and are housed in permanent buildings. The production capacity per line per month is 1500 tons of TNT. The labor required is six men/line/shift, compared to 16-18 men for the old manual

batch lines. The remote control room is designed to service 10 lines.

CONTINUOUS CIL LINE	CONTROLS	
1	DDC + (remote-manual)	Operational since Nov. '74; good production since Oct. '75.
2, 3	local-manual	Cold checking starts Jan. '77, then will be shut down. Manual withdrawal of samples, and manual dumping.
4, 5, 6	DDC + (analog control) + (remote-manual)	Automatic sampling & titration.

DDC = direct digital control
manual = fixed set point
local = operators in the same area as the nitration and purification equipment.

Of the five AAP's visited by the study team, only Volunteer AAP has organized a formalized and professional training program for operators, with manuals, slides, films, exams, and training simulators (e.g., controls). The training program for the continuous TNT line lasted 10 weeks, and the supervisors took the course together with their men.

The courses trained operators for the following lines:

- o Continuous TNT
- o Direct strong nitric (DSN)
- o Ammonia oxidation plant (AOP)
- o Sulfuric acid regeneration (SAR; also termed oleum)
- o Acid fume recover (AFR)
- o Industrial liquid waste treatment

Estimated cost to prepare the training program is less than $300,000.

6. GENERAL

A. The morning of the arrival of our study team (30 November 1976), the main on-site transformer (single installation) for the production facility was lost, due to an insulator failure. The cause of the failure was attributed to the combination of moisture retention and cold (freezing) temperatures. A proposed installation of a second transformer for standby, had been recommended, but never funded. A spare transformer would improve on-site power system reliability but would not guard against a supply power system failure. It would seem that an on-site local generator standby or emergency power source sized to service critical operations is needed to satisfy safety requirements.

B. Fire, apparently caused by the power outage, occurred in the wash portion of line #1 and resulted in a single injury.

7. DATA RECEIVED

a. Organization charts (2)

b. ICI-US's response to Gen. Nord's inquiry regarding retention of skills; dated 29 October 1976.

c. "Decision Risk Analysis of Direct Digital Control TNT Lines", by Trier & Mazza of ARMCOM; report # AMSAR/SA/N-36, dated October 1976.

d. Sample of ICI-US's Training and Development Materials; 33 pp., dated 18 September 1973.

e. "Finishing and Packaging for DDC/CIL Process", SOP # 016, dated June 1974; 68pp.

f. "S.O.P. for the DDC/CIL Process - Nitration and Purification Area", SOP # 014, 2 vols., 628 pp; dated September 1974.

g. "Problems in Reactivating a TNT Plant", by W. H. Ruth of Atlas Chemical Industries (now ICI-US), VAAP. Presented to P&E Section of AOA at Holston AAP in 1966.

Five AAP's representative of the P & E, LAP and metal parts production categories were selected as follows:

Lone Star AAP
Scranton AAP
Radford AAP
Iowa AAP
Volunteer AAP

2. SUMMARY

The Scranton AAP was visited to determine the current status of production lines and equipment, both operating and in layaway. The only operational line (producing metal parts for the 155mm M107) was evaluated in detail from a standpoint of mechanization and controls.

3. BACKGROUND INFORMATION, SCRANTON AAP

a. Scranton AAP is the only operational GOCO metal parts plant in the U.S. Their current production rate of 24,000 parts/month is 12% of their mobilization requirements, and their current level of contractor manpower is 480 (compared to a high of 1800 in 1968).

b. The contractor-operator is Chamberlain Manufacturing Corporation, and the plant is located in Scranton, PA.

4. INTERVIEWS

a. Comments by government personnel are summarized as follows:

1) Controls for modern machinery are primarily electronic, and the union's seniority policies make it very difficult to retain the most skilled electronic technicians (since they are usually the younger persons with little seniority).

2) It is and has been necessary to modernize (i.e., replace) most of the equipment without interrupting metal parts production. Consequently, start-up of new equipment has been slow.

3) Some of the new equipment (e.g., machining of the 8" shell) was put into layaway without debugging.

4) Voss Machinery Company of Pittsburg is considered to be experienced at equipment layaway and maintenance thereafter.

5) Any funding essentially requires a three-year cycle.

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PLANT EQUIPMENT PACKAGE (PEP) MODERNIZATION PROGRAM. VOLUME 11.--ETC(U)

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b. Comments by Chamberlain personnel are summarized as follows:

1) Skills retention is an essential factor of successful start-up. (Discussion of this subject revealed the existence of General Nord's
2 inquiry--see Item 7.d. under "DATA RECEIVED".)

2) Suggestions regarding recommended layaway practices included:

- Drain the pipes (when possible) that run through layaway areas.
- Completely fill all gearboxes with oil.
- Use or specify gold-plated contacts for electromechanical power relays.

5. EVALUATION OF 155MM PRODUCTION LINE

a. Billet Separation

1) The top surface of the bar stock is grooved $\frac{1}{4}$" deep by mechanized flame cutting.

2) The bar is cold broken by a press into 105 # billets.

3) Any defects which could cause laminations, cold shuts, etc. are manually chiseled from the fracture surfaces of the billet.

b. Preheat

1) Multiple rotary furnaces (only one operating), oil or gas fired, to heat billets to 2200 F.

2) Three billets/station and 65 stations. Sixty-five minute cycle and station movement once a minute.

3) Allen-Bradley solid-state control panels. Billet location indicator. Manual overrides.

4) Knowledgeable operator, who also monitors the descaling operation.

c. Hot Forging (cup, pierce, and draw)

1) Three forging "centers"; two centers with two Bliss presses and one transfer machine, and one center with three Erie presses and two transfer machines. Conventional controls, automatic sequencing with manual overrides.

2) Cup and pierce operations are done by the first Bliss press, and drawing by the second press. The transfer machine also rotates the part to cavity-down position and blast cleans the cavity. Life of the mandrel (over foot long) varies from 100 to 800 pieces, with 500 average. The mandrels can be reworked about three times. Nominal production rate is 150 parts per hour.

3) Each of the three Erie presses performs one of the forging operations.

d. Cooling and Descaling

The shells, at approximately 1800 F, are expelled from the draw press down onto a long conveyor in the basement, where they cool to ambient temperature. Descaling (inside and out) is done with conventional shot blasting equipment.

e. Rough machining (prior to nosing)

1) Two all-new lines planned; one has been operational since April, 1976, but is still considered to be in the debugging stage (apparently due to material handling difficulties, especially the interconnecting conveyor).

2) The operational line includes conventional Detroit tracer lathes and an Accumatic pusher conveyor. The nose and cutoff operation appeared to be unusual. Rather than a simple cutoff in one operation in one machine, a groove is machined at the nose end in the first machine, and the part is then transferred to a second machine. At the first station of the second machine, the nose is sheared off. The part is then indexed to the second station, where the sheared edge is face broached.

f. Nosing through Palletizing, etc, the equipment has been "modernized", but is very conventional and not at all complex. The Holcroft heat-treat furnaces are not operational, due to a million-dollar fire in one of the quench tanks. It is understood that the fire would have been averted if the furnace system had included a simple limit switch, actuated by extreme temperature of the quench oil.

6. GENERAL NOTES

a. Material traceability (by heat number) is maintained through the HT&Q operation of the manufacturing process.

b. Maintenance would be simplified by greater use of machine standardization; e.g., one make and model of forging press, rather than two.

c. Layaway

1) The machining equipment that was replaced about 1971 was layaway stored in the basement. Layaway consisted primarily of light oiling and paper dust covers. Volume 21 of the 1970 "Modernization Engineering Project for U.S. AAP's", Contract No. DAAA21-69-C-0788, described most of this equipment in terms of:

"... obsolete and should be scrapped."
"... fair to extremely poor condition."
"... high maintenance costs ..."

etc.

2) The new machining line for the 8" projectile is stored in place, some in hutments (wood framing plus plastic film), and some covered with paper. Many of the gear boxes were disassembled, cleaned, and re-assembled (a spec. requirement).

d. The contractor is obviously operating with the handicap of parts production concurrent with equipment modernization.

7. DATA RECEIVED

a. Scranton AAP booklet (general data, dated July 1976); 20 pp.

b. Organization charts (3)

c. Economic Analyses, DOD Investment, Summary of Project Costs; projects 5732672 and 5742600 (MUCOM); 37 pp total

d. Letter from BG A. A. Nord, ARMCOM, to Chamberlain Manufacturing Corporation, dated 29 September 1976, regarding retention of skills; with Concept Paper.

e. Letter from Chamberlain to BG Nord, responding to his inquiry.

RKR/dsl

APPENDIX D

Appendix D

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY ARMAMENT COMMAND
ROCK ISLAND, ILLINOIS 61201

REPLY TO
ATTENTION OF:

DRSAR-PPI

22 SEP 1976

SUBJECT: Definition and Policy - Layaway During Austere Funding Periods (ARMCOM Production Base)

SEE DISTRIBUTION

1. During the current period of reduced requirements for ammunition, an extensive program to layaway those facilities not required to support the lowered demand is underway. However, along with the increased demand for layaway, ARMCOM is experiencing tighter funding constraints. Consequently, every effort must be made to get maximum utility from each layaway dollar.

2. The purpose of this policy letter is to reemphasize the elimination of non-essential items, improve management effectiveness, assure proper utilization of program resources, and provide uniform guidance for layaway.

3. The specific intent of the Army Layaway of Industrial Facilities (LIF) Program is to assure the availability of essential equipment and facilities for future production in accordance with scheduled capability and capacity. Maximum attention must be directed to the retention of long leadtime, hard-to-obtain, critical equipment. This is necessary in order to conserve critical resources, and effectively utilize limited controlled humidity storage as well as limiting the total of items stored in uncontrolled storage space.

4. To that end, the inclosed general policy guidance has been formulated to insure that all installations perform the layaway function in a uniform manner (Incl 1). The formal guidance governing the layaway of Government equipment is contained in:

AR 210-17	-	Inactivation of Installations
AR 700-90	-	Army Industrial Preparedness Program
AMCP 235-1	-	Maintenance and Layaway of Facilities
ARMCOMR 420-2	-	Government-Owned Contractor-Operated Plant Facilities, Maintenance and Repair

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ENGINEERS

22 SEP 1976

DRSAR-PPI
SUBJECT: Definition and Policy - Layaway During Austere Funding Periods (ARMCOM Production Base)

ARMCOMR 385-5 - Decontamination Procedures

MIL-STD-107E - Preparation and Handling of Industrial Plant Equipment for Shipment and Storage

TM-38-260 - Preparation of Industrial Plant Equipment for Storage or Shipment

5. In general, the intent of any layaway project is to protect existing equipment in the configuration at the time of production cessation. The project will not support acquisition of new material or equipment to upgrade a facility unless failure to do so will affect the ability to respond to mobilization demands. If in doubt on a particular action, the question should be referred to ARMCOM for resolution.

FOR THE COMMANDER:

1 Incl
as

William T. Green

WILLIAM T. GREEN
Colonel, GS
Chief of Staff

DRSAR-PPI 22 SEP 1976

SUBJECT: Definition and Policy - Layaway During Austere Funding Periods (ARMCOM Production Base)

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Cdr, Louisiana AAP, Shreveport, LA 71130
Cdr, Milan AAP, Milan, TN 38358
Cdr, Newport AAP, Newport, IN 47966
Cdr, Radford AAP, Radford, VA 24141
Cdr Rep, Ravenna AAP, Ravenna, OH 44266
Cdr, Riverbank AAP, Riverbank, CA 95367
Cdr, Scranton AAP, Scranton, PA 18501
Cdr Rep, St. Louis AAP, St. Louis, MO 63120
Cdr Rep, Sunflower AAP, Lawrence, KS 66044
Cdr, Twin Cities AAP, New Brighton, MN 55112
Cdr, Volunteer AAP, Chattanooga, TN 37401

LAYAWAY POLICY

1. In the absence of specific instructions to the contrary, termination of current production schedules or impending completion of a modernized facility which will not be utilized in production will be sufficient to initiate immediate decontamination and layaway in accordance with the referenced regulations. In some cases, adequate justification, e.g., anticipated production orders, may be sufficient to hold a line in an idle state for a specifically defined period. These cases will be reviewed individually and no blanket exemptions to immediate layaway will be granted. This policy is necessary since no maintenance funding is available for idle lines which have not been laid away. Clean-up and decontamination will be performed in strict accordance with the procedures outlined in ARMCOMR 385-5. Any deviation from decontamination guidelines will be on a case-by-case basis following review by ARMCOM Safety (DRSAR-SF). Production funding will be used for decontamination for a line that was in production. Decontamination necessary as a result of modernization or prove-out will be funded from the project.

2. The installation will also prepare and submit to ARMCOM, 90 days prior to end of a production program, a project for layaway of the facility/installation in accordance with AR 700-90, Army Industrial Preparedness Program. Essentially this entails application of the facility layaway plan or elements thereof along with an estimate of the cost. AR 700-90 allows 10% of the replacement value of physical plant to layaway a facility. However, experience has shown that 5% or less of the replacement value of the IPE is a more realistic amount. In any case, each project will be reviewed and funding will be provided based on the approved scope of work.

3. The decision to maintain the facilities and equipment in a high, medium, or low state of readiness will not influence layaway techniques and cost. There is no difference in the layaway procedure and scope of work for a facility to be kept in a high, medium or low state of readiness. The difference is in the level and degree of maintenance following layaway. While most of the procedures are outlined in the regulations cited in the basic letter, many of them are not iron clad and innovation is encouraged. Thus, the installation should exercise appropriate technical judgement in the proposed scope of work. Specific details will be determined during on-site review. New techniques and innovations will be disseminated by ARMCOM on a periodic basis.

4. As a general statement, the installation should be selective in the layaway. Even if a line is to be retained, it does not necessarily follow that each and every support building should receive equal attention. Secondary buildings (i.e., change houses, sanitary facilities) which are relatively inexpensive and can be readily replaced within the mobilization time frame should receive only minimum layaway.

5. Electrical plant loops, water and sanitary units not in use will be laid away as specified in AMCP 235-1. Utilities required for standby operations shall be maintained in a high state. Above ground utility and process lines shall be preserved as necessary to prevent undue deterioration.

Incl 1

Preservation of equipment, structures or process lines shall be limited to application of preservative or spot painting for protection. No painting for appearance will be supported. Deteriorated insulation shall be stripped back to the nearest good insulation and the ends capped. The underlying line shall be coated with preservative. Insulation will not be replaced. Interior steam lines will be left as is with one exception. Insulation may be replaced on interior lines where it will reduce the operating cost during the period the facility is in layaway. Any lines constructed of corrosion resistant metals shall receive no protective coating. Any lines under cover, which are normally painted during operations, shall have a good grade primer spot applied after rust removal. If 50% or more of the line requires priming/painting, the entire line shall be prime coated. Any other lines shall have preservative applied as required.

6. The degree of rehabilitation and to some extent, the preservation required for buildings will vary somewhat as the age, type of construction, and climatic conditions will vary between installations. However, it will be limited to the minimum effort to assure structural integrity and weather protection for the installed equipment. As stated above, any buildings which are of minor importance and which can be replaced with their installed equipment within the specified time frame shall receive only minor effort. Water lines shall be drained and anti-freeze put in traps. Utilities shall be turned off and the buildings sealed in accordance with the cited regulations (minimum of one entrance required). Because of possible reduced staffing of some plant fire fighting personnel, it may become necessary to keep sprinkler systems active. Therefore, minimal heat may also be required to prevent freezing of the sprinkler systems. Heat may also be necessary to prevent freezing of roof drains, reduce snow load and prevent floor heaving. Technical assistance will be requested from HQ ARRCOM to determine whether to keep these systems active. These systems may be shut down only after approval. Production buildings of major importance shall receive any necessary repairs to insure that they are weather tight and give sufficient protection to the installed equipment. In most cases, reglazing will not be supported. Broken windows should be sealed by the most economical method. Roof leaks will be patched. Reroofing will be supported in the layaway project only if other repair is not economical over the following five year period. Structural repairs will be reviewed on a case-by-case basis but will be supported only when necessary to protect installed equipment or the structural integrity of semi-permanent or permanent buildings. Structural repair work should normally be accomplished with production funds or with the PS&ER project. All warehouses, magazines and igloos not in use for storage and which can be replaced within the mobilization time frame shall receive the same treatment as other minor buildings. Barricades which can be replaced within the mobilization time frame and which have deteriorated and present a threat to another structure by collapsing, shall be removed and useable material salvaged. Ramps and walkways shall be renovated only if they constitute a safety hazard. All openings should be sealed to prevent entry by birds or other wild life.

Repair or replacement of bricks on brick lined stacks, tanks, boilers or kilns will not normally be accomplished until after M-Day if it does not adversely affect the startup within the mob time frame. Brickwork will be removed if it is a safety hazard. A case-by-case analysis of the requirement for replacing brickwork should be accomplished.

7. The preservation of production equipment is the prime function of layaway and it should be considered first when resources are allocated. The detailed instructions for preparing and preserving equipment and the proper type of preservative are given in the regulations referenced in the basic letter. As a first step in project review, the equipment package should be purged to insure that only essential or critical equipment such as Industrial Plant Equipment, Other Plant Equipment, Inspection Equipment, Special Tooling and Manufacturing Aids, required to be retained in a layaway status on M-Day to meet the planned mobilization schedule are retained. Avoid storage and maintenance of equipment, tooling and material which may be acquired after M-Day in sufficient time and quantity to meet the required production schedule.

a. In considering equipment to be retained in the Plant Equipment Package (PEP), the criteria for retaining essential/critical equipment is as follows:

(1) Decisions will be based on the lead time for acquisition and/or replacement of each specific item required for mobilization production. Items unobtainable during the M-Day build-up period should be retained. This includes items of standard manufacture as well as special design items. The determination must be made with an eye toward supporting mobilization based on the M-Day build-up period; not on current acquisition possibilities.

(2) Equipment to be purged must be considered individually and a determination made for specific items and the disposition to be considered. Decisions will be made on the following:

(a) Furnaces, metal preparation systems, washers, conveyors, and like items (if it is intended that items are to be retained in place) will be retained in the packages.

(b) All material handling equipment including fork lifts, tow motors, dollies, etc., not required for maintenance purposes or for other ongoing plant functions will be made available through disposition actions to other users. Special purpose material handling equipment which is unique to the facility will be retained. Items will not be retained for any purpose other than to support mobilization.

(c) Expendable tooling, manufacturing aids and similar commercially obtainable items including hand tools will not be retained in the package. Specialized tooling, shop manufactured, or procured will be retained based on the criteria established in paragraph 7a(1) above.

(3) A determination of the need to either layaway or dispose of equipment scheduled for replacement as a part of current or planned PS&ER projects will be made as part of the on-site review. The major factors in this determination will be the cost of layaway as opposed to replacement and the useful life left in the item(s). Replacement will be limited to those items already scheduled for replacement that were reviewed and approved by higher headquarters. In some cases, equipment may be excessed without immediate replacement as part of the layaway project. If the resultant void will not affect M-Day build-up, it may be filled following M-Day. If the void will impact build-up, action to replace the item should be initiated following the procedures in AR 700-90, Chapter 5.

(4) Some spares, commonly referred to as insurance items, will be retained and laid away. These items will normally have a long procurement lead time and if unserviceable, could adversely affect production. A typical example would be a large diameter glass coupling in an acid transfer line. These items will be reviewed and approved by the cognizant technical office at HQ ARRCOM.

b. Controlled humidity storage shall be used sparingly and only where required. Delicate, expensive or intricate equipment requiring this type of storage should, to the extent practicable, be moved to a central location for controlled storage. When this is not feasible, hutments should be erected over the equipment. The use of sheet plastic covers with strip heaters and desiccant should be minimized since these covers are vulnerable to tearing. Desiccant should be used in conjunction with a moisture indicator to insure it has not become saturated.

c. The following applies specifically to test and measuring, inspection/acceptance and calibration equipment.

(1) Retain all required calibration equipment regardless of unit dollar value. Any DIPEC reportable items should be designated Category 4F to preclude removal by DIPEC.

(2) Low value common items that can readily be obtained during mobilization should not be placed in layaway. Examples are standard low cost micrometers (excluding super micrometers), and dial indicators. If the sum total of the items to be disposed of would constitute a severe procurement workload that could jeopardize the mobilization schedule, a reduced number of these items can be retained as part of the layaway package.

(3) High cost, long lead time items such as chamber gages, and fuze spin testers must be retained to meet mobilization requirements. HQ, ARMCOM (DRSAR-QAE) will maintain centralized inventory controls of these items. The items will no longer be returned to the Central Gage Laboratory at Iowa AAP for centralized storage. Low cost Army designed acceptance/inspection equipment that can be fabricated locally within mobilization schedules should not be placed in layaway. Care should be exercised to preclude the possibility that the sum total of the small items does not constitute an undue procurement or fabrication workload that would jeopardize mobilization schedules.

(4) Low cost, short lead time contractor designed acceptance/inspection equipment should not be retained. High Cost (over $1000) government-owned contractor designated equipment should be retained if required for mobilization. DRSAR-QAE will maintain inventory control of these items.

(5) Special purpose, high cost (over $1000) commercial equipment such as Detroit Band Testers will be retained if required for mobilization. DRSAR-QAE will maintain inventory control of these items. If not already included in the PEP, DIPEC should be requested to add them to the package.

(6) The quality assurance elements at the Army Ammunition Plants are responsible for notifying DRSAR-QAE of their intent to declare as excess any inspection equipment including all test and measuring equipment. The letter of intent must also indicate the number of identical items that are being retained for current production and mobilization requirements.

(7) Specific procedures for the layaway of quality assurance equipment are delineated in letter, AMSAR-QAE, HQ, ARMCOM, 20 Sep 74, subject: Layaway Package Policy.

d. The following will address the balance of plant equipment. The comments offered cannot address each specific item or problem but are presented as guidelines. Individual problems may be addressed to HQ, ARRCOM or may be settled during on-site reviews.

(1) Critical surfaces must be protected (die faces, lathe beds, etc.).

(2) Equipment will be disassembled only to the extent necessary to preserve the item. In some cases, the equipment will have been disassembled for decontamination. To the extent practical, the two operations should overlap to minimize duplicating effort by follow-up of layaway after performance of decontamination.

(3) Bearings with grease fittings will not be disassembled. Grease seals will be replaced as necessary. New grease will be forced in until the old grease is displaced.

(4) Valves of less than 2" diameter, unless of special design, will not be disassembled and preserved.

(5) Small diameter piping, other than that directly associated with instrumentation, which is readily replaced, will not be preserved.

(6) Power conveyors will be greased or oiled. Rollers and frame will be spot primed or completely primed as required after rust removal. Live roller conveyors will be greased or oiled. Conveyors without bearings will receive no preservation. Belt conveyors will have the belt removed. Serviceable belts will be cleaned, rolled loosely and wrapped in E2 or M waterproof paper. Unserviceable belts will be disposed of and replaced at startup. Conveyor stands, if wooden, aluminum, stainless steel, plastic or galvanized steel will not be processed. Other materials will be cleaned and spot primed as necessary.

(7) Vari-Drive units will not be disassembled. Oil or grease shall be drained and replaced during layaway. Operate with no load to insure even distribution of lubricants. Sprocket wheel and chain should be cleaned and preservative applied.

(8) Electric motors in class 1 and class 2 housing will not be disassembled unless there is evidence of explosive contamination or other damage. In no case shall a motor of less than 20 HP in an explosion-proof housing be disassembled unless there is evidence of contamination. In all other cases, the motor should be lubricated, repaired as necessary, and the exterior cleaned and primed or painted as required.

(9) Exterior electrical service boxes should be cleaned, preserved, and fuzes removed. Fuze contacts should be coated with electrical grease. Boxes should then be sealed. Interior boxes shall be left with no preservation. AMCP 235-1 furnishes instructions for layaway of other electrical equipment.

(10) Painting will be performed for preservation and not merely for appearance. Spot rust removal, priming and painting is encouraged during layaway to minimize general painting later with standby funds.

(11) Radiators will be disconnected, drained and the openings screened to prevent access of foreign objects. This will apply to unit heaters, duct type, steam coils, condensate tanks and deluge systems.

(12) Heavy shafts should be supported to ease weight on bearing surfaces. Failing this, the shafts should be removed or rotated periodically.

(13) Steel tankage susceptible to corrosion, including that under shelter, will be cleaned and preserved. If the equipment is normally painted during operation, good grade primer should be used. If not, an approved preservative should be used. In some cases, it may be desirable to continue acid storage in appropriate tanks since this may be an effective corrosion inhibitor and may also aid in startup.

(14) Electric elevators must be laid away.

(15) As a general statement, equipment will not be laid away with the intent of cycling as part of the standby or follow-on maintenance. In special circumstances, cycling will be permitted on a case-by-case basis. Any plan to perform periodic cycling of laid away equipment will require written justification by the operating contractor, review and recommendation by the COR staff and final decision by HQ, ARRCOM. Consideration will be given to cycling equipment which is subject to permanent damage due to inactivity, equipment which cannot be economically repaired at the time of startup if not cycled, and equipment which can be cycled at a minimal cost.

(16) There is no definitive policy on layaway of computer equipment at present. Pending further guidance, this equipment should be retained in dehumidified storage not to exceed 40 percent relative humidity. When the guidance is formulated, it will be disseminated to the addressees.

8. Other areas for consideration are contained in AR 210-17. In general, personnel should be housed in the minimum facilities practical. Utility plants and systems should be reduced to a minimum. The use of small package boilers is preferable to operating large power houses. Wells should be used to minimize water treatment facilities. If wells are used, some provision must be made for water softening. Only those portions of sewage plants required to meet state and/or Federal EPA discharge standards should be used. Further, no portion of the system not required to meet normal needs shall be kept active.

9. Detailed justification of the need for the project and backup data for requested funding will be required for every proposed layaway effort. This data will normally be verified during on-site review.

10. Finally, when a facility is no longer required, consideration should be given to the status of modernization plans prior to performing a complete layaway. In some instances, the complete line need not be laid away if it is due for replacement in the near future. A concerted effort to excess and dispose of buildings for which there is no projected need must be made. However, caution must be used when considering disposal of existing facilities. In general, facilities are to be laid away if mobilization requirements exist and modernization has not been funded. If, in the judgment of the plant staff, a facility should not be laid away based on modernization plans, HQ ARRCOM should be requested to prepare a decision risk analysis and provide definitive guidance.

The layaway project is not normally the proper vehicle to obtain funding for rehabilitation or other required repairs. Facilities and equipment should be properly maintained, including preventive maintenance during production. Repairs or rehabilitation will be supported as part of layaway only in unusual circumstances and will require detailed justification. Any modifications to the facility or acquisition of production equipment deemed necessary as part of the layaway effort shall be referred to HQ, ARMCOM for approval.

11. Following completion of the layaway, the project will be inspected for acceptance by appropriate technical representatives of HQ, ARMCOM.

APPENDIX E

APPENDIX E

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY ARMAMENT COMMAND
ROCK ISLAND, ILLINOIS 61201

98.

REPLY TO
ATTENTION OF:
DRSAR-PPI

29 SEP 1976

Mr. Edward Solowiej
Chamberlain Mfg. Corp
Scranton Army Ammunition Plant
Scranton, PA 18501

Dear Mr. Solowiej:

The inclosed Concept Paper deals with a problem long recognized in the ammunition community, namely, retention of skills.

We solicit your views on this concept, suggestions for its practical implementation, as well as any alternatives which could meet the basic objective. We are interested in your corporation position, although no commitment of any kind is intended on the part of the Army or your company at this time. We also recognize that any program could only be in effect for the life of the operating contract.

We request that you identify those modern or otherwise unique facilities that you would nominate for priority consideration in the initial phases of this program.

It is planned to include this concept of a Personnel Resource Package on the Agenda of the next Plant Commanders' Conference in December. Consequently, it is requested that you reply by 29 October 1976. Please address your response and any questions you may have to Mr. G. H. Cowan, DRSAR-PPI, Extension 6513.

Sincerely,

Alan A. Nord

ALAN A. NORD
Brigadier General, USA
Director, Procurement
and Production Directorate

1 Incl
As stated

CF:
Cdr, Scranton AAP

VANGUARD OF FREEDOM
UNITED STATES ARMY

AMERICAN REVOLUTION BICENTENNIAL
1776-1976

KAISER ENGINEERS

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CONCEPT PAPER

TITLE: Personnel Resource Package (PRP) for Production Base Support Activities.

PURPOSE: To propose an approach for dealing with the primary missing link in our production base planning, -- retention of skills.

ASSUMPTIONS:

1. The great majority of our modern, more sophisticated facilities for the manufacture of ammunition as well as certain older unique facilities will be in an inactive status over the next ten years.

2. As time goes by, know-how within the Operating Contractor staffs will disappear unless a positive program exists.

3. The reorganization of the armament community will tend to emphasize development rather than production expertise within our Arsenals, particularly with time.

FACTS:

1. At present, there is no conscious program within the Army to identify, retain, and train a cadre of mid-management and technical specialists needed to rapidly reactivate facilities under emergency conditions.

2. The Army already has, in existence, many new facilities for which only limited production or prove-out experience has or will be obtained prior to layaway.

3. The Army is spending literally hundreds of millions of dollars annually to create and maintain the buildings and equipment, and other physical assets but nothing for the personnel to run them, except where activity itself supplies the expertise.

DISCUSSION:

1. The following concept is proposed to remedy the above problem:

a. Each plant Operating Contractor would identify their foremost mid-management level specialist for each major production process at their plant. This person must have tenure and be expected to remain with the corporation for a period of at least three years.

Incl 1

b. This person would be the one relied upon to train the first level supervision and operators who would be required to operate the key facilities of the plant. He would normally be assigned that function under reactivation.

c. The Operating Contractor would, for an agreed upon consideration, maintain the identity of the individual regardless of interim assignment and make him available for training and updating on an annual basis.

d. The ARRCOM would establish a training program for selected facilities and processes to assure that know-how and skills are retained. This would be financed as a specific annual program under O&MA 728011, or similar fund.

e. When, due to retirement or promotion to a position requiring removal from the program, a reassignment was required, the Operating Contractor would designate a replacement. Designation should meet, to the extent possible, the same experience and tenure requirements cited above. To the extent practicable, such an individual would be given "hands on" extensive training at an active plant or through simulation to assure that he attains the proper skill level.

f. Complementary to the establishment of a cadre of contrator personnel, at least one Civil Service employee, currently employed within ARRCOM or ARADCOM, would be designated for each plant (or major process category) as a specialist to participate in the training program. The purpose here is to provide Government continuity and feedback. The individual so assigned would also have an emergency designation to participate in reactivation.

g. Each COR staff should also be represented in the training program where appropriate.

2. It is expected that this program could be executed annually at a very small fraction of our production base budget but would markedly improve the readiness status of our facilities.

RECOMMENDATION:

It is recommended that this concept be reviewed by the P&P staff and the Director. If approved, a letter be written to each Operating Contractor explaining the concept and requesting their reaction. If favorable, steps be taken to implement at the earliest date.

KAISER
ENGINEERS

DAY & ZIMMERMANN, INC.
(LONE STAR AAP)

Refer to						

3??-1213

DM-8500/PM/JBR

October 26, 1976

BEST AVAILABLE COPY

Mr. G. H. Cowan
DRSAR-PPI
United States Army Armament Command
Rock Island, Illinois 61201

Dear Mr. Cowan:

RE: Letter from General Nord
dated 29 September 1976
Subj: Personnel Resource Package
(PRP) for Production Base Support

I am extremely pleased to see that ARMCOM is proposing action to retain essential skills in the ammunition industry. It is absolutely imperative that certain specific expertises be maintained to assure the capability to respond if and when an emergency arises.

Regarding the Concept Paper, Paragraph 1a of the Discussion section indicates that each Contractor would identify their foremost mid-management level specialist for each major production process at their plant. We respectfully submit that no one individual has the expertise required to rapidly activate a modernized line containing automated equipment. Based on our experience with automated production facilities for detonators, primers and 155MM Projectiles, M483, additional individuals should be retained with expertise in the areas of engineering, quality control and maintenance.

Implementation of such a concept poses no problem. As a matter of policy, we are currently maintaining such expertise even though individuals may not be working in their particular field. Should the situation arise that there are no alternate jobs which these people could perform, i.e., no production schedules (zero base), these people could be used to maintain the plant with time allotted each month for training and review of inactive operations in which they have peculiar expertise.

Mr. G. H. Cowan
DRSAR-PPI
United States Army Armament Command

Refer to October 2?, 1978

May we also suggest that you seriously consider giving the plants greater participation in R&D and MM&T Projects, and development of pilot lines and prototype equipment. This, coupled with schedules reduced monthly but stretched out over a longer period of time, would aid considerably in maintaining the warm base and required expertise.

Lone Star production facilities which we nominate for priority consideration in the initial phases of this program are:

155MM and 8" Projectile, M483/M509

81/60MM Mortar

105MM Projectile

Fuzes, M534/M557/M567

Light Antitank Weapon (LAW), M72A2

Hand Grenade, M67

Detonator, Delay, Relay, etc.

Primer

Supplementary Charge

Sincerely,

JOE B. RAFFAELLI, JR.
Plant Manager

JBR/gd

cc: COR, LSAAP
bcc: WRM
LCH

KAISER ENGINEERS

MASON & HANGER----

(IOWA AAP)

29 October 1976

Mr. C. H. Cowan
DRSAR-PPI
ARMCOM Headquarters
Rock Island, Illinois 61201

Dear Mr. Cowan:

We have reviewed your "personnel resource" concept and believe it has substantital merit. Therefore, per your request, we have listed below (not necessarily in order of priority) the principal skills we believe are vital to the conduct of our operations at IAAP.

1) L/A/P of detonators, primers and other components -- especially those skills applicable to drying, screening and mixing of primary explosives (lead azide, lead styphnate, tetracene, etc.) and the set-up, maintenance and operation of the automatic loading equipment required for these items.

2) Mechanical pressing of high explosives -- especially those skills applicable to the set-up, maintenance and operation of pressing equipment.

3) L/A/P of cartridges and projectiles -- especially those skills applicable to melting, pouring and cooling high explosives and the set-up, maintenance and operation of the production equipment associated with these operations.

4) A working knowledge of the safety requirements for handling primary and secondary explosives plus the physical and chemical properties of these explosives.

5) Technical expertise in the field of electronics, fluidics and other control media, particularly as they relate to some of the complex process control systems at IAAP.

KAISER ENGINEERS

Mr. G. H. Cowan, DRSAR-PPI
ARMCOM Headquarters
Page 2

29 October 1976

We trust this list of skills represents the kinds of information you are interested in. If this is not the case, please feel free to call me at the Iowa Army Ammunition Plant.

Very truly yours,

MASON & HANGER-SILAS MASON CO., INC.

R. L. Holmberg
Plant Manager

RLH/dib

bc: D. E. Heffelbower, Lexington
Information Services (2)
R. L. Holmberg

HERCULES INCORPORATED

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA 24141

October 28, 1976

Reference: Letter to Mr.
H. R. Davies, RAAP, dated
September 29, 1976, from
Brigadier General A. A. Nord

Contracting Officer's Representative
Radford Army Ammunition Plant
Radford, Virginia

Dear Sir:

The reference letter addressed to Mr. H. R. Davies, requests a Hercules corporation position on the concept of a Personnel Resource Package, along with suggestions for implementation. A similar request was addressed to the Plant Manager at Sunflower Army Ammunition Plant.

Attached is a copy of a letter of response by Mr. R. G. Sailer, Director, Plant & GOCO Operations, presenting the Hercules corporation views and position. Mr. Sailer has transmitted the letter addressed as requested in the reference letter.

Very truly yours,

H. R. Davies

H. R. DAVIES
MANAGER

HRD:rd

Attachment

HERCULES INCORPORATED

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA 24141

October 26, 1976

Commander
Department of the Army
Headquarters, United States Army
Armament Command
Rock Island, Illinois 61201

Attention: Mr. G. H. Cowan, DRSAR-PPI

Dear Sir:

This letter is in response to Brigadier General Nord's letter to the Plant Managers of the Radford and Sunflower Army Ammunition Plants, dated September 29, 1976, concerning retention of skills.

Hercules Incorporated, as an Army Ammunition Plant Operating Contractor, is highly in favor of inaugurating a program which would retain and develop individual skills necessary for the proper functioning of ammunition related facilities. We have, in previous correspondence, expressed our concern and the importance we attach to maintaining operating skills that would be needed in the event that Mobilization should become necessary.

In order to accomplish skills retention and to produce the small quantities normally needed in peacetime, at least one facility for each process should remain active; that is, somewhere in the GOCO complex a nitrocellulose unit should operate - somewhere acid should be manufactured, etc.

Our suggestions for implementation are based on an assumption that RAAP will remain active to an extent approximating current production plus at least one active TNT Line (when the TNT lines become available), and that SAAP will in due course have an active nitroguanidine facility, but will otherwise be inactive. Under this assumption, RAAP and SAAP would serve as the training sites for the operations listed below:

RAAP

Nitric and Sulfuric Acid
Nitroglycerin
Nitrocellulose
TNT
Single-Base and Multi-Base Solvent Extruded Propellants,
both conventional and modernized processes
Cast and Solventless Extruded Rocket Propellants
Conventional Carpet Roll
Ballistics Testing

SAAP

Nitroguanidine
Mechanized Carpet Roll
Continuous Paste

Attachment A represents a proposed skill retention and training plan for the SAAP plant, and Attachment B for the RAAP plant.

Hercules would be willing to maintain and conduct training programs in the operations remaining active, and to make suitable personnel available for retraining from any source within the corporation subject to mutually acceptable contract terms.

Very truly yours,

R. G. Sailer /s/

R. G. Sailer, Director
Plant & GOCO Operations

RGS:gfb

Attachments

Attachment A

Suggestions for Implementation of the Personnel Resources Plan
For Production Base Support Activities
Sunflower Army Ammunition Plant

I. Nitroguanidine

Active Operations at SAAP

Produce Nitroguanidine

Mid-management Level Specialist

It is proposed that the Nitroguanidine Project Manager be assigned the Specialists responsibilities. These responsibilities would include:

a. Management of the Nitroguanidine operations.

b. Continual maintenance of Production Expansion and Mobilization Staffing and Training Plans for the SAAP Nitroguanidine operations.

c. Conduct annual "hands on" refresher training courses in the SAAP actively producing Nitroguanidine facilities for any personnel who may not be actively occupied with the Nitroguanidine plant, but designated as a back-up Specialist because of qualifications and past experience.

II. All Other SAAP Operations

It is assumed that all other SAAP operations will be inactive, and that the designated Specialist for each will be refresher trained annually in the active operations at RAAP.

The list below depicts the SAAP operations in order of priority that would be required for retention of skills. Also listed is the minimum number of people required to be retrained. The number of people for each major process is determined by the operation complexity, back-up requirements, and location of training.

Sunflower Training Priority by Major Process

Process	People to be Retrained
Multi-Base (Conventional)	1 + 2 back-up
Mechanized Carpet Roll & Cont. Paste	5 *
Batch Carpet Roll	1 + 1 back-up
Rocket Grains	3 + 3 back-up
Ballistic Testing	1 + 1 back-up
Nitroglycerin	1 + 1 back-up
Nitrocellulose	1 + 2 back-up
Acid	1 + 2 back-up

* Training at Sunflower - no back-up was allowed because should one person terminate another would have to be hired.

Attachment B

Suggestions for Implementation of the Personnel Resources Plan
For Production Base Support Activities
Radford Army Ammunition Plant

I. Nitric and Sulfuric Acid Production

Active Operations at RAAP

Produce 98% Nitric Acid by the Ammonia Oxidation and Concentration Processes.

Produce 40% Oleum by the Sulfuric Acid Regeneration Program.

Reconcentrate Nitric and Sulfuric Acids from spent acids produced by the Nitrating Processes.

Mid-management Level Specialist

Using the terminology of the RAAP organization, it is proposed that a Chemical Process Superintendent be assigned the Specialist responsibilities.

This Superintendent would report to the Chemical Process Department Manager.

These responsibilities would include:

a. Management of the current acid production operations.

b. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP acid operations.

c. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing RAAP acid facilities in the event of Mobilization. Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as designated by ARMCOM.

d. Conduct annual "hands on" refresher training courses in the RAAP actively producing acid facilities for personnel from other plants, as designated by ARMCOM.

e. Maintain surveillance and periodic assessments of the condition and mobilization production capability of the inactive ARMCOM acid production facilities.

II. Nitroglycerin Operations

Active Operations at RAAP

Produce Nitroglycerin by the continuous Biazzi process.

Produce nitrate esters of materials such as di-ethylene glycol, and propylene glycol by the batch nitration process.

Mid-management Specialist

It is proposed that the Nitroglycerin Area Supervisor be assigned the Specialist responsibilities. This Supervisor will report to the Chemical Process Superintendent referred to in I. above.

These responsibilities would include:

a. Direct supervision of the Nitroglycerin Area and its production operations.

b. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP Nitroglycerin operations.

c. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing NG facilities at RAAP, in the event of Mobilization. Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as designated by ARMCOM.

d. Conduct annual "hands on" refresher training courses in the RAAP actively producing NG facilities for personnel from other plants, as designated by ARMCOM.

e. Maintain surveillance and periodic assessments of the condition and mobilization production capability of the inactive ARMCOM Nitroglycerin production facilities.

III. Nitrocellulose Operations

Active Operations at RAAP

Nitration of cotton linters and of wood pulp by the Continuous Nitration Process (IN).

Purification of Nitrocellulose by the Conventional Purification Processes.

Mid-management Specialist

It is proposed that a Chemical Process Superintendent, reporting to the Chemical Process Department Manager, be assigned the Specialist responsibilities. These responsibilities would include:

a. Management of the RAAP Nitrocellulose operations.

b. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP Nitrocellulose operations.

c. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing Nitrocellulose operations at RAAP, in the event of Mobilization.

   Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as directed by ARMCOM.

d. Provide Operating Procedures to other plants that have installed IN nitration units. Maintain a continual notification system to these other plants of changes in procedure, equipment improvements, and "lessons learned" in the course of active operations.

e. Conduct "hands on" training courses for IN nitration operations in the actively producing RAAP operations, for key personnel from other plants who have installed IN nitrators which have not been actively operated. Conduct annual refresher training courses in the actively producing RAAP IN nitration and Nitrocellulose purification operations for personnel from other plants, as designated by ARMCOM.

f. Maintain a START-UP ASSISTANCE PLAN, which will provide for RAAP personnel to be supplied for start-up assistance for IN nitrator operations at other plants who have installed IN nitrator units that have not been started up.

g. Maintain surveillance and periodic assessments of the condition and mobilization production capability of the inactive ARMCOM Nitrocellulose production facilities.

h. Be available to conduct an assessment, based on current IN nitrator operating experience and practices, of installed equipment and piping for IN nitrator units at other plants which have installed but not operated, if requested by ARMCOM.

IV. TNT Operations

Active Operations at RAAP

None active at present. Current schedule for resuming active operations in the TNT Area at RAAP is mid-1979. Two lines will be available at that time, with one or two lines actively producing, dependent on production schedules.

Mid-management Specialist

It is proposed that the TNT Area Supervisor be assigned the Specialist responsibilities. He will report to the Chemical Process Superintendent listed in III. above.

These responsibilities would include:

a. Direct supervision of the RAAP TNT production operations.

b. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP TNT operations.

c. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing TNT operations at RAAP, in the event of Mobilization.

   Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as directed by ARMCOM.

d. Conduct annual "hands on" refresher training courses in the RAAP actively producing TNT facilities, for personnel from other plants as designated by ARMCOM.

e. Maintain surveillance and periodic assessments of the condition and mobilization production capability of the inactive ARMCOM TNT production facilities.

V. Propellant Operations

Active Operations at RAAP

Produce solvent type extruded propellants, single-base and multi-base. Produce propellant product items and intermediates by the Roll Process for mortar increments, carpet rolls, and sheet stock. Produce rocket propellants by the Solvent Extruded Process. Produce rocket propellants by the Cast Process.

Mid-management Specialist

It is proposed that two Specialists be designated for the current propellant processes, each classified as a Propellant Superintendent. One Superintendent to be designated as the Specialist for the Single-Base and Multi-Base Solvent Extruded Propellants (batch processes), and one Superintendent to be designated as the Specialist for the Rolled Powder, Solventless Extrusion, and Cast Processes. Each of these Superintendents to report to the Propellant Department Manager.

The responsibilities of each of these Specialists are of the same nature:

a. Manage the actively producing RAAP propellant production operations for which he is the designated Specialist.

b. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP propellant operations for which is he responsible.

c. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing propellant facilities at RAAP, in the event of Mobilization. Conduct the training courses provided in these plans, in the event of Mobilization, as designated by ARMCOM.

d. Conduct annual "hands on" refresher training courses in the RAAP actively producing propellant facilities, for personnel from other plants as designated by ARMCOM.

e. Maintain surveillance and periodic assessments of the condition and mobilization production capability of the inactive facilities of ARMCOM designated for production of the product types for which he is the Specialist.

VI. Modernized Single-Base and Multi-Base Operations

Active Operations at RAAP

Currently, these processes are in the project stage; therefore, there are no active operations in Continuous Automated Single-Base or Continuous Automated Multi-Base operations.

When these projects have been completed and started up, it is assumed that these will become active RAAP operations as production schedules permit.

Mid-management Specialist

It is proposed that the current Program Manager for each process will be the designated Specialist. It is expected that each of these two current Program Managers will continue in the programs for the foreseeable future. However, in the event that either of these is transferred to another assignment, it is proposed that he will continue to be obligated as the Specialist unless and until a qualified substitute designation is made.

The responsibilities of the Specialist are:

a. Continual maintenance of PRODUCTION EXPANSION AND MOBILIZATION STAFFING AND TRAINING PLANS for the RAAP operations for which he is the designated Specialist.

b. When other plants are provided with modernized single-base or multi-base propellant facilities, maintain MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively producing facilities at RAAP, in the event of Mobilization.

   Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as directed by ARMCOM.

c. Conduct annual "hands on" refresher training courses in the RAAP actively producing facilities, for personnel from other plants as designated by ARMCOM.

VII. Technical and Engineering Specialists

A. Control System Maintenance

Several of the modernization projects at Radford involve sophisticated process control systems. The designated Production Specialists discussed in the above sections are depended on to have the knowledge to utilize the control systems for process control. However, the functioning of the control system hardware is of equal importance. The Production Specialist must, of necessity, be supported by others that have specialist knowledge of the mechanism, its functioning as a mechanical and electrical device, and maintenance of the control system hardware.

It is proposed that Control System Specialists be selected and designated on the basis of knowledge and competence for the specific systems involved (competence for control systems in general is not adequate).

It is proposed that each of the following control systems at RAAP have a designated Control System Specialist. (In practice one individual may possibly be designated as a Specialist for more than one system, but in all probability would not be designated for all these systems.)

1. Continuous Automated Single-Base Line (CASBL) Control System.

2. Continuous Nitrator for Nitrocellulose (IN) Control System.

3. Continuous Automated Multi-Base Line (CAMBL) Control System.

4. Sulfuric Acid Regeneration Plant Control System.

5. Nitric Acid-Sulfuric Acid (NAC-SAC) Concentrator Control System.

6. TNT Nitration and Purification Control System.

The responsibilities of the Control System Specialist toward the system for which he is the designated Specialist are:

1. Preserve and maintain a complete set of system operation and maintenance instructions, manuals, drawings, etc.

2. Continual maintenance of MOBILIZATION STAFFING AND TRAINING PLANS to provide for an expanded personnel staff to service the RAAP control system in the event of shutdown and later, Mobilization.

3. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of mechanics or supervisors from other plants in actively producing operations at RAAP, in the event of Mobilization. Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as directed by ARMCOM.

4. Conduct annual refresher training courses in the actively operational facility at RAAP for personnel from other plants, as directed by ARMCOM.

5. Maintain surveillance and periodic assessments of the condition and reactivation capability of the inactive RAAP control systems for which he is the designated Specialist.

B. Propellant Performance Control

The control of performance properties of propellant products, adjusting formulation and configuration to meet performance specifications is a technical skill that must be available to the Process Specialist at Mobilization and Reactivation.

It is proposed that Technical Specialists be designed for families of propellant products. These are:

Solvent extruded propellants
Solventless propellants
Cast and rocket propellants

Those individuals designated as Specialists will be committed to being made available for annual refresher training and for service in the event of Mobilization.

C. Ballistics Testing Operations

Active Operations at RAAP

Ballistics Testing operations, testing those products in the RAAP production schedule, including reduction and analysis of acquired data.

Mid-management Level Specialist

It is proposed that the Ballistics Area Supervisor be assigned Specialist responsibilities.

These responsibilities would include:

1. Direct supervision of the RAAP Ballistics Area operations.

2. Continual maintenance of MOBILIZATION STAFFING AND TRAINING PLANS for RAAP Ballistics operations.

3. Continual maintenance of MOBILIZATION TRAINING PLANS for intensive training of operators and supervisors from other plants in actively operating Ballistics operations at RAAP, in the event of Mobilization.

   Conduct the training courses provided in these plans, in the event of Reactivation or Mobilization, as directed by ARMCOM.

4. Conduct annual "hands on" refresher training courses in the RAAP actively operational Ballistics Area, for personnel from other plants as designated by ARMCOM.

5. Maintain surveillance and periodic assessments of the conditions and mobilization capability of the inactive RAAP Ballistics facilities.

D. Equipment Maintenance

Equipment Maintenance Specialists for RAAP production operations should normally be available as long as the level of active operations remains about as it is currently.

In the event of discontinuance of all production operations at RAAP, the Maintenance Department should be designed and supported by program funds to incorporate the Equipment Maintenance Specialists in the Maintenance After Layaway organization. Since an organization is subject to losses of personnel through retirements, illness, etc., a plan for annual refresher equipment training courses for selected critical equipment maintenance situations should be built into the maintenance program.

VIII. It is proposed that a complete roster of Specialists along with their qualifications and responsibilities will be maintained current at all times as a contractual requirement, and that for each Specialist named one or more back-up alternates will be designated.

KAISER ENGINEERS

bcc: Messrs. C. W. Truebe (2)
R. E. Yoder
J. W. Kimbell
R. C. Hauze
K. B. Malone
P. M. Coyle
Engineering Central File

ICI - UNITED STATES, INC.
(VOLUNTEER AAP)

BEST AVAILABLE COPY

29 October 1976

Mr. G. M. Cowan
DARSAR-PPI

Dear George,

Ref: Letter dated 14 October 1976 from Brigadier General Alan A. Nord to Carl Truebe

We have reviewed the Concept Paper which was attached to the referenced letter above, and we are in full agreement with the intent and purpose of the Concept Paper. It has been the contention of ICI United States Inc. in the past several years that the problem has existed, and a logical approach to the saving of the expertise required to run the new modern facilities built by the Army should be initiated.

In 1966 ICI-US, then known as Atlas Chemical Industries, recognized the need for and supported a modernization program for the TNT facilities. The modernization program was implemented and has been carried through to the current status. We are now at the point where the final phase of the modernization program is to be considered. The purpose of the Concept Paper is a natural step in the modernization program to assure the Army of a successful program resulting in a reliable production facility.

The successful completion of the modernization program at VAAP to date has resulted in a most sophisticated and technically complex production facility utilizing the latest in explosives manufacturing technology. It is the individual operating units at this facility which must be considered under the Personnel Resource Package Program concept. The following units at Volunteer Army Ammunition Plant are recommended for priority consideration in the initial phases of this program:

1. CIL TNT Production Lines 1 Through 6
2. Acid and Fume Recovery Units C-1 and C-2
3. Ammonia Oxidation Plant
4. Direct Strong Nitric Plant
5. Spent Acid Recovery Plant
6. Liquid Waste Treatment Plant

To support the above-named facilities under the program, we offer the following cadre for consideration:

Explosives Area:

2 Chemical Engineers (TNT, AFR, DDC Software & Process)
2 Electrical Engineers (TNT, AFR, DDC Hardware & Process)
2 Mechanical Engineers (TNT, AFR, DDC, Process Equipment)
1 Production Superintendent (TNT, AFR Operations)

Acid Area:

1 Chemical Engineer (AOP, DSN, SAR, ILWTF, Process)
1 Mechanical Engineer (AOP, DSN, SAR, ILWTF, Equipment)
1 Production Superintendent (AOP, DSN, SAR, ILWTF, Operations)

Support Area:

1 Chemical Engineer (Pollution Abatement)
1 Chemist (Quality Assurance)
1 Maintenance Supervisor (Facility Maintenance)
1 Safety Engineer (Acid & Explosives Operations)

The above cadre contains all engineering disciplines plus production and maintenance support expertise required to meet an early mobilization schedule. The personnel required to develop this cadre are presently at VAAP and are covered under existing production, modernization, and special project funds. This cadre of expertise can be made self-amortizing through proper utilization in on-going modernization, research and development, mobilization and training development programs. If this approach is not feasible, special funding should be made available to retain these disciplines. As requested in your letter, we offer the following suggestions for the practical implementation of the Concept Paper:

Each Operating Contractor would provide a small cadre of expertise at their respective plants and ICI United States Inc. would, for example at VAAP, be assigned the responsibility for assuring that a homogeneous group of expertise is available to support the mobilization plan under an accelerated schedule and provide the following services:

1. Insure that the Personnel Resource Package is maintained.

2. Insure that all operational data and training programs necessary for mobilization of all the explosive facilities are available and are continually updated.

3. Insure that all modern technology is evaluated and applied to the facility on a continuing basis to maintain the state of the art for the government during periods of deactivation.

4. Maintain facilities for and provide new methods of training personnel through an active production facility and/or simulation procedure.

5. Develop a comprehensive coordinated description of manufacture for VAAP incorporating all up-to-date technology.

This cadre of expertise can be expanded through training and/or manpower to provide the necessary technological expertise for mobilization at other TNT and similar explosives production facilities.

In addition to the mission to maintain the expertise for operation of the GOCO plant, and realizing the knowledge contained within this cadre, the potential for providing the complex with a consulting engineering group must be realized. By funding this group with future R&D projects it will be essentially self-supporting. As was stated in a letter to our Plant Commander on 8 October 1976 from Major General R. J. Malley, ICI-US Inc. at Volunteer was praised for continued leadership in the modernization technology program. Both management and government personnel have worked hand-in-hand at Volunteer in past modernization development programs and are dedicated to the application of solar energy technology to reduce the dependence of the processes on fossil fuel energy and the development of a Total Energy Management Plant concept.

The Engineering Planning Group has successfully developed and will continue to foster ideas in support of the modernization program which have directly benefited the entire TNT production complex. Looking to the future, the logical continuation of this group would be in support of the Concept Paper (Personnel Resource Package for Production Base Support Activities).

As a result of the Concept Paper and the amendments offered by ICI United States Inc., we would welcome the opportunity to present a more detailed proposal for your consideration.

Sincerely yours,

Carl W. Truebe

Carl W. Truebe
Plant Manager

CWT/RCH/KBH/bms

cc: VAAP - COR

KAISER
ENGINEERS
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Scranton Army Ammunition Plant
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27 October 1976

Commander
ATTN: Mr. G. H. Cowan, DRSAR-PPI
U.S. Army Armament Command
Rock Island, Illinois 61201

Dear Mr. Cowan:

The following comments are made based on the assumption that if the plant were completely idle and in a laid away condition there would be, on site, a skeleton force for the maintenance of the plant and equipment. This force would consist primarily of Maintenance personnel, Security and minimal Management. Any personnel retained for Modernized and/or Unique Facilities would be in addition to the above mentioned complement.

The personnel retained should be given the task of developing, on individual plant bases, detailed training procedures for various production and maintenance operations, procedures for reactivation and other necessary aids to be implemented in the event of an emergency requirement. The experience of the retained personnel would be a great asset in the preparation of these aids.

MODERNIZED AND/OR UNIQUE FACILITIES

A. Forging Systems, to Include Furnaces, Presses and Automated Handling
B. Automated Rough Machining Systems
C. Automated Nosing, Including Induction Heating
D. Atmosphere Controlled, Computerized Heat Treating Systems
E. Automated Finish Machine Line, Including Bore Nose, Finish Turn, Base Boattail and Band Groove Machining, Weld Base Cover, Band Seating and Band Machining
F. Utility Services to Include:
   1. Water Recirculating Systems - Three Encompassing The Total Facility
   2. Electrical Power Transformation and Distribution
   3. Boiler Room and Steam Distribution
   4. Air Compressors and Distribution
   5. Monitoring Stations for Waste Products to City Sewerage Systems, for Pollution Control.

It is estimated that the above listed areas would require the retention of nine (9) or ten (10) mid-management persons. In time of emergency and the need to expand the plant complement to M-Day production levels, these people would be responsible for training the necessary work force. This expanded work force would consist of up to:

	4th Month	8th Month
Production Personnel	1,300	2,300
Maintenance	390	560
Tool Room	100	150
Quality Control	140	230
	1,930	3,240

The retention of a minimal nucleus of mid-management personnel and a planned annual training and improvement program is considered to be a major step in the right direction. However, the need to rapidly expand production, should an emergency arise, would overtax the training capabilities of such a small group.

It is very questionable that personnel with the necessary skills and expertise would be attracted to or willing to remain in, an idle plant with little or no activity on a continuing basis. There must be some activity creating a continuing demand for the active participation of these retained people.

There are other approaches which, in our opinion, offer better probabilities of not only maintaining the necessary mid-management skills but maintaining an actual work force nucleus with operating skills and experience.

1. The unrestricted use, on a rent-free, non-interference basis, of Government Owned Facilities and Equipment for production of Commercial items.

2. The retention of selected, Core, plants in a "warm" status, producing at a reduced rate but prepared to accept newly developed items and ready for immediate expansion of production, should the need arise.

KAISER ENGINEERS

ATTN: Mr. G. H. Cowan, DRSAR-PPI
27 October 1976
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3. The use of facilities, equipment and personnel for MM & T studies and projects, Production Engineering, and small quantity production in support of Arsenals in the development of new items. An example of this is the future closing of Frankford Arsenal. Scranton AAP can support the requirements of Picatinny Arsenal, on large caliber items until such time as Picatinny Arsenal becomes self-sufficient in this area.

One area which has not been addressed in this discussion is the subject of sub contractors. There are several areas of prime importance where sub contractors should be addressed to retain the necessary capabilities for required production levels. In many cases associated with Metal Parts Production sub contractors are not involved with Government Owned Facilities or Equipment. Some consideration must be given to the retention of sub contractor capability.

Very truly yours,

Edward Solowiej

Edward Solowiej
Vice President
General Manager

ES:vn

bc: G. Smith
G. Bergstrom
[illegible]

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APPENDIX F

Appendix F

GENERAL PROVISIONS

Part 15—Options

1-1501 Scope of Part. This Part applies to contracts for supplies and services other than for (i) the construction, alteration, or repair of buildings, bridges, roads, or other kinds of real property and (ii) research and development. It does not preclude the use of appropriate option provisions in such construction and research and development contracts.

1-1502 Definition. As used in this Part, an option clause is a provision in a contract under which, for a specified time, the Government may elect to purchase additional quantities of the supplies or services called for by the contract, or may elect to extend the period of performance of the contract.

1-1503 Applicability.

(a) Option clauses may be included in contracts where increased requirements within the period of contract performance are foreseeable, or where continuing performance beyond the original period of contract performance may be in the best interest of the Government. Since options require offerors to guarantee prices for definite periods of time with no guarantee that orders will be placed, their improper use could result in prices which are unfair to either the Government or the contractor. Option clauses may require that option quantities be offered at prices no higher than those for the initial quantities or they may allow option quantities to be offered without such limitation as to price. When additional requirements are foreseeable and subsequent competition would be impracticable because of such factors as production lead time and delivery requirements, the use of options which require prices no higher than those for the initial quantities may be preferable to later negotiating a price with the contractor at a time when he is the only practical source. An option normally should not be used where it can reasonably be foreseen that (i) minimum economic production quantities will be procured at some future date, and (ii) startup costs, production lead time, and probable delivery requirements would not preclude adequate future competition.

(b) Option provisions and clauses shall not be included in contracts when:

- (i) the supplies or services being purchased are readily available on the open market;
- (ii) the contractor would be required to incur undue risks: *e.g.*, the price or availability of necessary materials or labor is not reasonably foreseeable;
- (iii) an indefinite quantity contract or requirements contract is appropriate except that options for continuing performance may be used in such contracts;
- (iv) market prices for the supplies or services involved are likely to change substantially; or
- (v) the option quantities represent known firm requirements for which procurement funds are available unless (A) the basic quantity is a learning or testing quantity and there is some uncertainty as to contractor or equipment performance and hence Multi-Year Procurement is not appropriate, and (B) realistic competition for the option quantity is impracticable once the initial contract is awarded.

(c) When options are to be evaluated pursuant to 1-1504(d), the total of the basic and option periods shall not exceed five years in the case of services, and the total of the basic and option quantities shall not exceed the requirement for five years in the case of supplies. This five year limitation shall not apply to Automatic Data Processing Equipment acquisitions; however, the basic and option periods shall not exceed the approved systems life as defined in the Federal Property Management Regulations.

1-1504 Procedures.

(a) When a contract is to contain an option clause, the solicitation must contain an appropriate option provision. If the contract is to be negotiated, the determination and findings shall set forth the approximate quantity to be awarded and the extent of the increase to be permitted by the option. The contract shall limit the additional quantities of supplies or services which may be procured, or the duration of the period for which performance of the contract may be extended, under the option and will fix the period within which the option may be exercised. This period shall be set so as to afford the contractor adequate notice of the requirement for performance under the option but with respect to service contracts may extend beyond the contract completion date when exercise of the option would obligate funds not available in the fiscal year in which the contract would otherwise be completed. In fixing the period within which the option may be exercised, consideration shall be given to (i) necessary lead time in order to assure continuous production and (ii) the time required for additional funding and other necessary approval action. The period specified for exercising the option shall in all cases be kept to a minimum. When a solicitation contains an option which requires the offering of additional quantities of supplies at unit prices no higher than those for the initial quantities, it shall provide that the option quantities shall not exceed 50% of the initial quantity. When unusual circumstances exist, however, the Chief of the Purchasing Office may approve a greater percentage of quantity. The quantities and the period under option and the period during which the option may be exercised shall be justified and documented by the contracting officer in the contract file.

(b) Except as provided in (c), (d) and (e) below, solicitations containing option provisions shall state that evaluation will be on the basis of the quantity to be awarded exclusive of the option quantity.

(c) When it is anticipated that the Government may exercise the option at time of award, the solicitation shall include an Evaluation of Options provision substantially as set forth in 7-2003.11(a).

(d) In firm fixed price contracts, the option quantity may be considered in the evaluation for award if, before issuance of the solicitation, it has been determined at a level higher than the Contracting Officer that:

- (i) there is a known requirement which exceeds the basic quantity to be awarded, but either (A) the basic quantity is a learning or testing quantity and there is some uncertainty as to contractor or equipment performance, and hence Multi-Year Procurement (1-322) is not appropriate, or (B) due to the unavailability of funds, the option cannot be exercised at the time of award of the basic quantity *provided* that in this latter case there is reasonable certainty that funds will be available thereafter to permit exercise of the option; and

(ii) realistic competition for the option quantity is impracticable once the initial contract is awarded and hence it is in the best interests of the Government to evaluate options in order to eliminate the possibility of a "buy-in" (1-311). This determination shall be based on factors such as, but not limited to, substantial startup or phase-in costs, superior technical ability resulting from performance of the initial contract, and long preproduction lead time for a new producer.

In such cases, the solicitation shall contain an Evaluation of Options provision substantially as set forth in 7-2003.11(b).

(e) In fixed price incentive contracts, options may be evaluated for award only if the solicitation (1) specifies a cost-sharing arrangement applicable to all proposals, and (2) specifies that the ceiling price and target profit for the basic and option quantities are to be based on stated percentages of the offeror's target cost. These percentages shall be set forth in the solicitation and shall be applicable to all proposals. In such cases, the Evaluation of Options provision in 7-2003.11(c) shall be inserted in the solicitation.

(f) Solicitations which allow the offer of option quantities at unit prices which differ from the unit prices for the basic contract quantities shall also state that varying prices may be offered for the option quantities depending on the quantities actually ordered and the date or dates when ordered. However, if the solicitation contains an Evaluation of Options provision pursuant to (c) and (d) above, it shall also specify the price at which the options will be evaluated (e.g., highest option price offered or option price for specified quantities or dates).

(g) When exercise of the option would result in increased quantities of supplies, the option may be expressed in terms of (i) percentage of specific contract line items, (ii) a number of additional units of specific contract line items, or (iii) additional numbered line items identified as the option quantity with the same nomenclature as line items initially included in the contract. Where exercise of the option would result in an increase in the performance of services by the contractor, the option may similarly be expressed in terms of percentages, increase in specific line items, or additional numbered line items, expressed in terms of the units of work initially used in the contract such as man hours, man years, square feet, pounds or tons handled. Where exercise of the option would result in an extension of duration of the contract, the option may be expressed in terms of an extended terminal date or of an additional time period, such as days, weeks, or months.

1-1505 Exercise of Options.

(a) The exercise of an option by the Government requires the contracting officer's written notification to the contractor within the time period specified in the contract.

(b) When the contract provides for economic price adjustment and the contractor requests revision of price pursuant to such provision, or the provision applies only to the option quantity, the effect of economic price adjustment on prices under the option must be ascertained before the option is exercised.

(c) Options should be exercised only if it is determined that:

(i) funds are available;

(ii) the requirement covered by the option fulfills an existing need of the Government, (for purposes of determining whether to exercise the option, a Foreign Military Sales commitment undertaken by the U. S. Government on behalf of a foreign country is considered fulfillment of an existing need of the U. S. Government; however, for options covering *'commercially available items'* (see Chapter H of the Military Assistance Sales Manual - Part III) in foreign military sales, see 6-705.2(a)); and

(iii) the exercise of the option is the most advantageous method of fulfilling the Government's need, price, and other factors considered.

(d) Insofar as price is concerned, the determination under (c)(iii) above shall be made on the basis of one of the following.

(1) A new solicitation fails to produce a better price than that offered by the option. When the contracting officer anticipates that the option price will be the best price available, he should not use this method of testing the market but should use one of the methods in (2), (3), or (4) below (see 1-309).

(2) An informal investigation of prices, or other examination of the market, indicates clearly that a better price than that offered by the option cannot be obtained.

(3) The time between the award of the contract containing the option and the exercise of the option is so short that it indicates the option price is the lowest price obtainable, considering such factors as market stability and a comparison of the time since award with the usual duration of contracts for such supplies and services.

(4) Established prices are readily ascertainable and clearly indicate that formal advertising or informal solicitation can obviously serve no useful purpose.

(e) Insofar as the "other factors" mentioned in (c)(iii) above are concerned, the determination should, among other things, take into account the Government's need for continuity of operations and potential costs to the Government of disrupting operations, including the cost of relocating necessary Government-furnished equipment (as, for example, in certain repair and overhaul contracts for aircraft or other complex equipment).

(f) When it has been determined that an option may properly be exercised in accordance with the principles set forth herein, such determination shall be set forth in writing and made a part of the contract file. Written notification to the contractor of the exercise of the option and any contract modification resulting therefrom shall cite the option clause contained in the original contract as authority for the procurement of the option quantity; and no citation under 10 U.S.C. 2304(a) is required. Reporting, however, shall be in accordance with the instructions applicable to DD Form 350 (Individual Procurement Action Report).

1-1506 Examples of Option Clauses. Examples of Option clauses are set forth in 7-104.27 and 7-1903.22.

TABLE III-2

LINES SURVEYED
IOWA AAP SURVEY

End Items	Building	Line Status	Control Mode	Degree of Complexity* Mechanization	Controls	Comments
TOW, Dragon, & Hawk Warhead loading (melt, pour, & cool)	1-05-2	Operational for 2 years	Computer (direct digital control) process sequencing & data logging, but no corrective action; some air control; manual override & set points.	2	8	• Quality substantially better than manual line. • Production capability increased from 90 to 225 warheads/shift, using same manpower. • Overall product cost substantially reduced. • Only 4 hours of downtime in last 1-1/2 years of operation. • Machine & controls designed by Mason & Hanger.
Iowa loader for M2A2, M17, M24, M55, & M61 detonators	6-34-2	• One machine is operational for M2A2. • Ten Model 1 machines operated for 6 years, discontinued in 1975, in layaway.	Primarily mechanical, plus electrical & air fluidics	8	4	• Rotary index type of machine that has evolved from the WW-II vintage Jones Loader. 24 stations available. • Production rate is 40 to 44 detonators per minute. • Layaway & startup experience good. • Good reliability.
155-mm M107 assembly	3A-12	Shutdown in June 1976 for debugging.	Pneumatic & Allen-Bradley Cardloc	7	5	• Design production rate is 8 per minute. • Mechanized line will require 13 operators (24 for manual line). • Line includes automatic X-ray system, weighing, and supplementary-charge insertion.
155-mm drill system	3A-05-2	Inactive as of June 1976 after processing 1-million parts	Allen-Bradley Cardloc	5	5	• Line includes remote 8-spindle drilling, thread brushing, automatic inspection, and expanding-collect type of unloader.
Automatic powder weigh & primer insert (90-mm)	2-13	Laid away in 1974; expect reactivation soon.	Electrical-mechanical	5	6	• Except for one Unimate, line's equipment is relatively conventional.
M61 percussion primer machine	6-34-3	Dry debugged; never in production. Now in layaway.	Air, electrical, & mechanical	8	3	• Production rate is 250 parts per minute. Six operators required. • Design and machine considered excellent by Mason & Hanger engineers.
155-mm depalletizing	3A-04	Operational since 1974	Electrical, hydraulic, pneumatic	6	7	• Production rate is 2,500 shells per shift, which is twice that of adjacent manual line. Same manpower (6 required on both lines). • Metal banding is broken and pallet cover removed; two Unimates then remove plugs and transfer shells into fixtured car.

*On a scale of 1 to 10, with 10 being the most complex.

TABLE III-3

LINES SURVEYED
RADFORD AAP SURVEY

Endproduct	Production Line: Designation	Production Line: Status	Comments
Weak nitric acid (61% HNO_3)	Ammonia Oxidation Process (AOP)	Inoperative; Built in 1972, shutdown in 1974	• Reportedly a conventional and proven design, except for environmental-control innovation (not completely successful).
98% HNO_3 + 67-93% H_2SO_4 byproduct (input is weak nitric acid)	Nitric (or sulfuric) acid concentrator, #1 (NAC/SAC)	Operational since 1974	• Controls conventional for process industry. • Except for controls, all equipment open to atmosphere. • Very high maintenance; "self-destructive" type of plant. • Plant never shutdown unless required for maintenance.
	Nitric (or sulfuric) acid concentrator #2 & #3 (NAC/SAC)	95% complete	• Equipment in a building. • Reportedly a better design than #1 line.
Oleum (100% H_2SO_4 + absorbed SO_3)	Sulfuric acid regeneration (SAR)	Built in 1972. Now inoperative except for periodic cycling (every 3 months)	• Input is dilute H_2SO_4 byproduct from nitric acid concentrator line. • Line capacity greatly exceeds current needs, hence periodic operation that creates excessive maintenance (e.g., furnace refractory lining).
Nitrocellulose (NC), high or low grade	Improved nitrocellulose (IN)	Operational	• This proprietary continuous process replaced a batch line. • Controls are analog plus remote manual.
Single-base propellant	Continuous, automated single-base line	Scheduled start of prove-out and acceptance is February 1978	• Controls are direct digital control (DDC) plus limited local-backup manual control. • Compared to the WW-II vintage batch process that it will replace, this line requires only 25% as many personnel.